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Geochemical Hydrology of the Ground Water in Baton Rouge, Louisiana.

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GEOCHEMICAL HYDROLOGY OF THE GROUND WATER IN BATON ROUGE, LOUISIANA

A Dissertation

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ABSTRACT

Ground water geochemistry in the Baton Rouge area is intimately related with the hydrology of the region. Chemical character of the ground water is a function of several physico-chemical processes, principal among them are ion exchange, filtration due to clay compaction, mineral solubility and mixing of the waters.

Two genetic types among the ground water have been recognized, (i) Chloride water, contains usually high total dissolved solids, (ii) Bicarbonate water, which is a large complex group of fresh waters. Hydrochemical facies defined on the basis of ionic abundances are especially useful in interpreting the geochemical hydrology of the area. Sixteen different cation and anion combinations were used in defining the hydrochemical facies.

Chloride water is considered a mixture of diagenetically altered sea or estuarine water with fresh water. The chloride waters have originated from the dilution of original trapped salty water by fresh waters. Sodium dominant bicarbonate water is the result of ion exchange and membrane filtration. Membrane filtration is the most active in the area of maximum land surface subsidence. The Ca and Mg dominant bicarbonate waters at shallower depths are principally due to solution of carbonate minerals. The principal mechanisms responsible for the generation of each major water type may be augmented or modified by the other agents.

Regression analyses of the hydrologic parameters in this area upon hydrochemistry suggests that ionic character of the ground water is not related with the area of supposed recharge. The depth of occurrence, the Mississippi River and the extensive production of water in the industrial area are related to the chemical facies of the water. Sodium is inversely related to Ca and Mg abundance, and Ca and Mg are directly related to one another. Hydrochemical facies indicate that Baton Rouge fault acts as a hydrologic barrier.

CHAPTER 1

INTRODUCTION

Hydrologic studies include many aspects of the basic and applied sciences. Geology and chemistry have been used to augment hydrologic studies. Reviews of this aspect of hydrology have been presented by Hem (1959) and Back and Hanshaw (1965). Geochemical hydrology (or chemical geohydrology) is defined as, "the study of the portion of the hydrologic cycle that relates the chemical character of water to its environment". (Back and Hanshaw 1965, p. 50) This is a study of the chemical aspect of geohydrology of the Baton Rouge area.

Ground water in the Baton Rouge area has been the object of intensive hydrologic studies. The first account of the chemical characteristics of the ground water was published by G. D. Harris in 1905 (Turcan and Meyer, 1955). The Water Resources Division of the U. S. Geological Survey has since continously studied the ground water hydrology of this area and results of some of these studies have been published (Turcan and Meyer, 1955; Morgan, 1961, 1963). Later several studies supported by the Louisiana Water Resources Research Institute, were conducted to investigate the hydrogeology of the Recent Alluvium (Martinez, 1967) and shallower aquifers, including the University sand and the 400-600 foot sand aquifers (Smith, 1969). No detailed hydrogeologic analyses of the deeper sands, in

the Baton Rouge Industrial area have been made. General hydrogeologic information is available due to work of the U.S. Geological Survey (Cushing and Jones, 1945; Turcan and Meyer, 1955; and Morgan, 1961).

Until recently (Kazmann, 1970) it was thought that brackish water, by intrusion into fresh water aquifers, was contaminating the Baton Rouge ground water supply. Some of the studies related to brackish water occurrence of the brackish water in this area. Extensive reviews on the ground water resources of the Baton Rouge area were published by Louisiana Water R ources Research Institute (Kazmann, 1967, 1970), which has given mework in which this dissertation is written.

The object of this study is to relate the chemical composition and hydrology of the ground water in this area, explain the origin and distribution of dissolved chemical constituents, and establish a probable mechanism by which the ground waters may have acquired their present chemical character. In addition, the nature and movement of ground water in relationship to structural and hydrologic controls is presented. Ion exchange, differential solubility of the minerals constituting the aquifers, filtration of the dissolved constituents by clay aquitards as a result of compaction and mixing of water from two or more sources in the aquifer system are the major physico-chemical processes to be discussed with respect to their role in creating the observed chemical differences.

CHAPTER 2

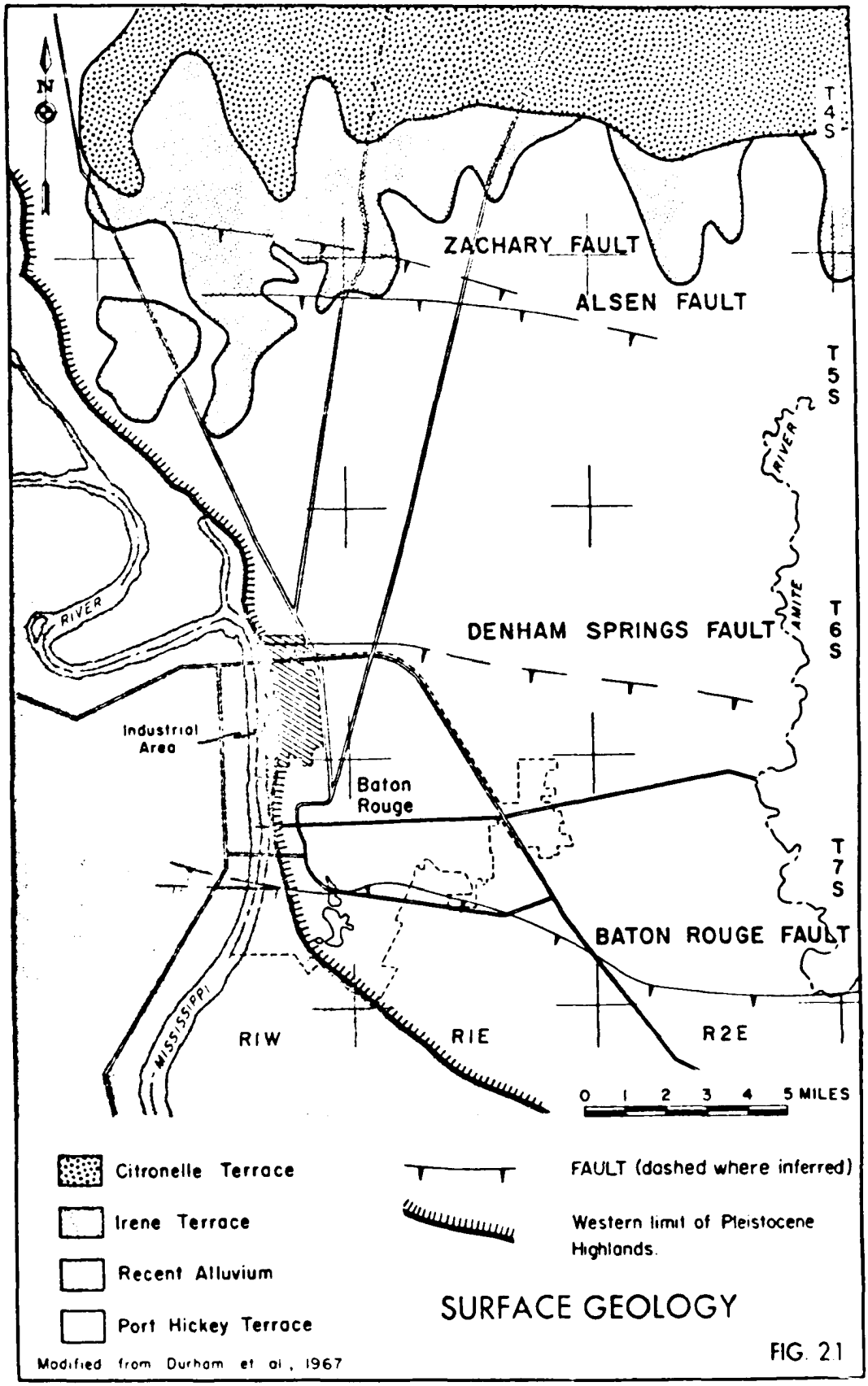
LOCATION, PHYSIOGRAPHY AND DRAINAGE

The Baton Rouge area is located approximately between 91°00' to 91°15' longitude and 30°22' to 30°37' latitude in the southeastern part of Louisiana, on the Gulf Coastal Plain.

Several rivers drain the area and may provide recharge to local aquifers. In addition to the Mississippi River, with an average flow of 480.10^3 cubic feet per second at Baton Rouge (U.S. Army Corp of Engineers, 1952, p. 50), there are a number of small rivers such as the Amite and Comite rivers. The Amite and Comite rivers originate north of Baton Rouge, draining various geological formations, which crop out in East and West Feliciana and adjoining parishes (Morgan, 1961; Parsons, 1967). These three rivers are thought to be the principal sources of recharge to the Baton Rouge ground water system.

The Baton Rouge area is underlain by about 600-800 feet of Quaternary sediments which blanket the generally southward dipping sedimentary formations of Tertiary age (Turcan and Meyer, 1955). Deposits of Recent age are encountered in the Mississippi River alluvial valley. Alluvial terraces of Pleistocene age are the most extensively exposed materials.

In the vicinity of Baton Rouge, two terraces have been identified (Durham, et al. 1967, p. E7). They are the Irene terrace lying on the Citronelle formation to the north and the Port Hickey



terrace south of Irene, (Figure 2·1). They form about 300 feet of sediments, overlying the 400-600 Foot sand aquifer in the Baton Rouge area.

Four normal faults have been mapped in this area (Durham and Peeples, 1956; Parsons, 1967). They are from north to south, the Zachary Fault, the Alsen Fault, the Denham Springs Fault and the Baton Rouge Fault. The last is considered by Kazmann (1970) a hydrologic barrier, (Figure 2·1) the others are not.

CHAPTER 3

GEOHYDROLOGIC FRAMEWORK

Studies of the hydrogeology of the Baton Rouge area have been made by Cushing and Jones (1945), Turcan and Meyer (1955), Cardwell and Rollo (1960), Morgan (1961, 1963), Meyer and Rollo (1965), Parsons (1967), Smith (1969), Rollo (1969), Kazmann (1970) and Wintz et al. (1970). Hydrological information obtained by them forms a framework in which the present study has been undertaken. It is necessary, therefore, to summarize the hydrogeology of the area under discussion.

Twelve fresh water aquifers are known, named after their approximate depth of occurrence, such as "Alluvial, University sand (300 foot sand), 400 foot sand, 600 foot sand, 800 foot sand, 1000 foot sand, 1200 foot sand, 1500 foot sand, 1700 foot sand, 2000 foot sand, 2400 foot sand, and 2800 foot sand aquifer". Three aquifers, namely the 400-600 foot sand, 1200 foot sand and 2000 foot sand are mainly pumped for large scale offtake (Morgan, 1961, p. 57). These aquifers supposedly crop out north of Baton Rouge, and have a general slope of about 15 feet per mile towards the south, dipping below Pleistocene sediments in the Feliciana parishes (Parsons, 1967).

The Alluvial aquifer system consists of the Alluvial aquifer and the University sand. These aquifers merge west of the Mississippi River (Smith, 1969). Turcan and Meyer (1955) and Morgan (1961) have shown direct connection between the Mississippi River and these

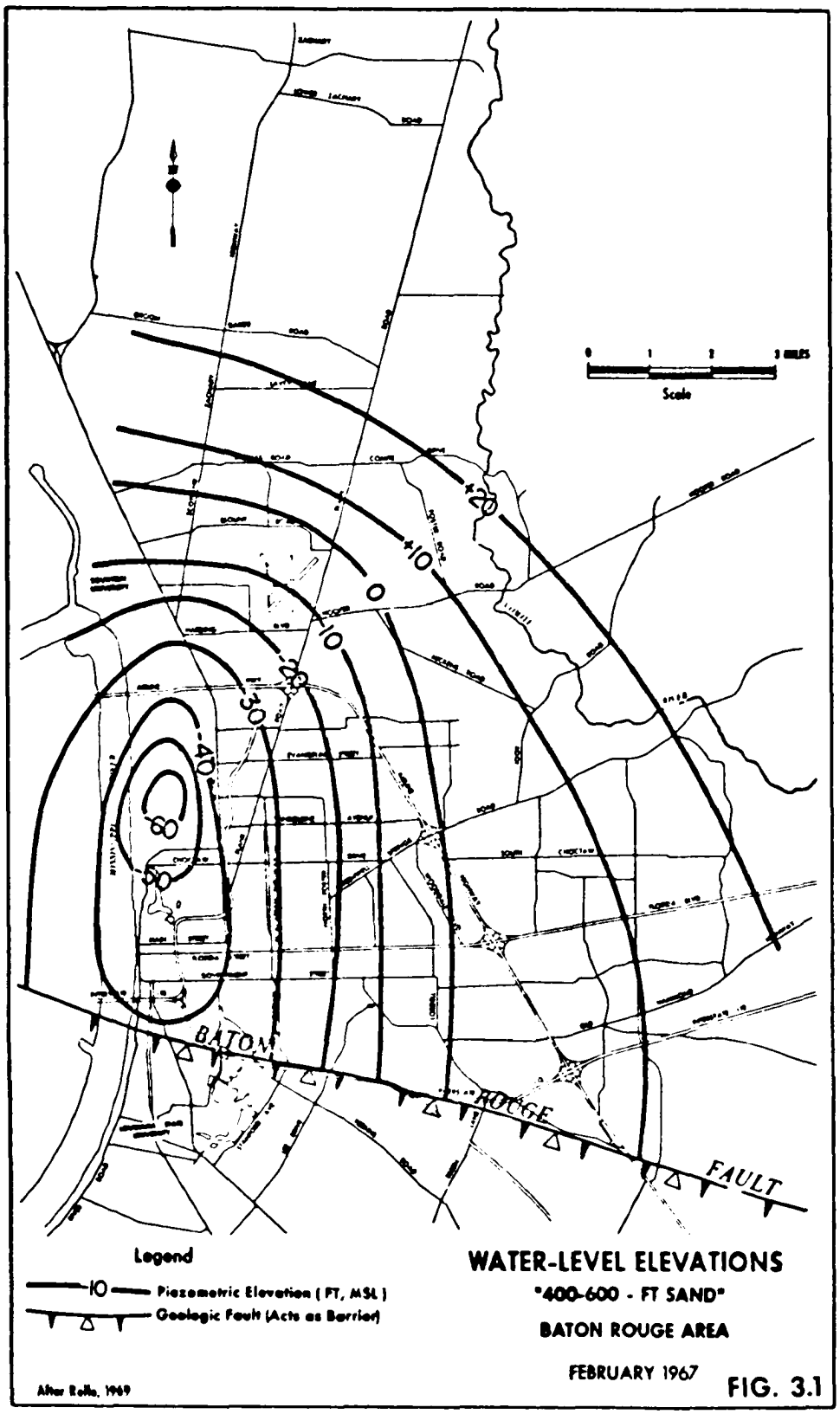


TABLE 3·1

HYDRAULIC PROPERTIES OF THE AQUIFERS IN BATON ROUGE AREA*

Aquifer	Transmissivity 10^3	Storativity	Permeability gpd/ft^2	Specific Capacity gpm/ft drawdown	Yield gpm
Alluvial Aquifer	140-210	0.001-0.009	1700	23.5-94.0	800-3750
University Sand	nd	nd	nd	nd	nd
400 Foot Sand	32.4-76.5	0.00026-0.00097	260-530	13.5-45.3	750-1500
600 Foot sand	88-123	0.00041-0.00061	520-800	12.8	430-1460
800 Foot sand	24.0	nd	270	13.2-36.3	950
1000 Foot sand	nd	nd	nd	15-26	nd
1200 Foot sand	22-120	0.00016-0.00085	300-800	7.8-42.9	300-1800
1500 Foot sand	76.5-90.4	nd	960-1160	14.7-54.7	300-1200
1700 Foot sand	32.0	nd	240	41.6	850-1000
2000 Foot sand	160-243	0.00071-0.00062	1100-1500	31.5-94.7	870-1800
2400 Foot sand	97.0	nd	590	15.9-45.5	600-1470
2800 Foot sand	nd	nd	nd	18.5-58.9	1150-1800

* Morgan (1961)

aquifers. The University sand is a sand and gravel bed which probably represents a Pleistocene river channel deposit. It pinches out close to the industrial center (Smith, 1969).

The "400-600 Foot Sand Aquifer System" consists of two aquifers, a 400 and 600 foot sand. The sands merge and form one geohydrologic unit, except in the industrial center (Smith, 1969). The water level elevations of 400-600 foot sands are shown in Figure 3·1. This unit has been traced to the Alsen Fault, which is close to Zachary area. Correlation between the hydrograph of the Mississippi River and the 400-600 foot sand aquifer has been established by Smith (1969). (Figure 12). Hydrologic properties of both aquifers are also similar (Table 3·1).

The 600 foot sand showed a rise in salinity from 1947 onwards (Kazmann, 1970, p. 5). The abnormal Cl content was detected in wells EB 123, 493, 500 and 806A, located north of the Baton Rouge Fault and just south of the industrial area, (Figure 4·1). The Baton Rouge Fault, however, acts as a hydrologic barrier allowing no northward flow into the shallower 400-600 foot sand aquifer. Smith (1969) and Kazmann (1970) showed with electric logs that brackish water north of the Baton Rouge Fault has no relation to that present south of the fault (well EB 818), but is probably moving from west of the Mississippi River. Contrary to this finding, Rollo (1969) found abnormal Cl in wells completed in the 1200, 1500 and 2000 foot sands (EB 782A, 782B, 781). Rollo interpreted the chloride as an example of leakage across the barrier. This occurrence of abnormal Cl is localized.

The alluvial aquifer system and the 400-600 Foot system merge west of the Baton Rouge area and are thought to be hydraulically connected to the Mississippi River by Smith, (1969). He could not establish any recharge from the Citronelle, which is believed to be laterally equivalent to 400-600 Foot sand, north of the industrial area.

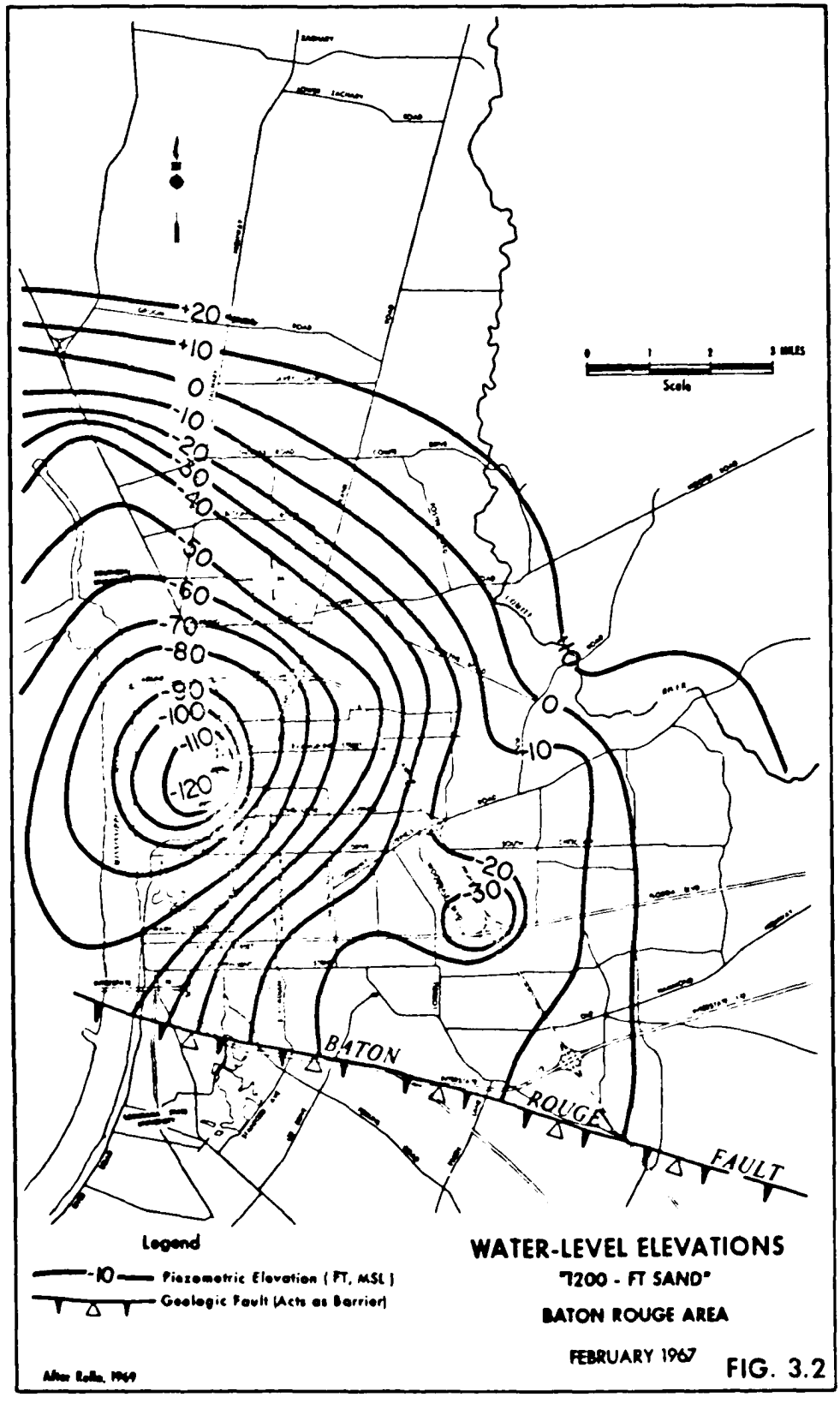
The 800 Foot sand aquifer is about 80-150 feet in thickness, composed of irregular sand lenses (Turcan and Meyer, 1955). Morgan (1961) reports a hydraulic connection with the 600 Foot sand, south of industrial center.

The 1000 Foot sand aquifer, which is about 40-80 feet thick, is a separate hydrologic unit in the industrial center. It merges with the 1200 Foot sand aquifer to the east and north (Morgan, 1961). The 1000 Foot sand is not a major aquifer.

The 1200 Foot sand is one of the main aquifers in the area of study, with a maximum thickness of 200 feet in the industrial center (Morgan, 1961). The potentiometric surface of the 1200 Foot sand aquifer is shown in the Figure 3-2. Offtake from this aquifer is primarily in the industrial center.

The 1500 Foot sand, (absent in the industrial center) consists of two to three sand bodies separated occasionally by clay. The clay however, does not affect the hydraulic continuity (Morgan, 1961). Thickness ranges between 100-300 feet. In the southeastern part of West Baton Rouge Parish, the 1500 Foot sand merges with the 1700 Foot sand.

The 1700 Foot sand aquifer is irregular in occurrence, has a thickness of about 240 feet and is better developed in the northwest



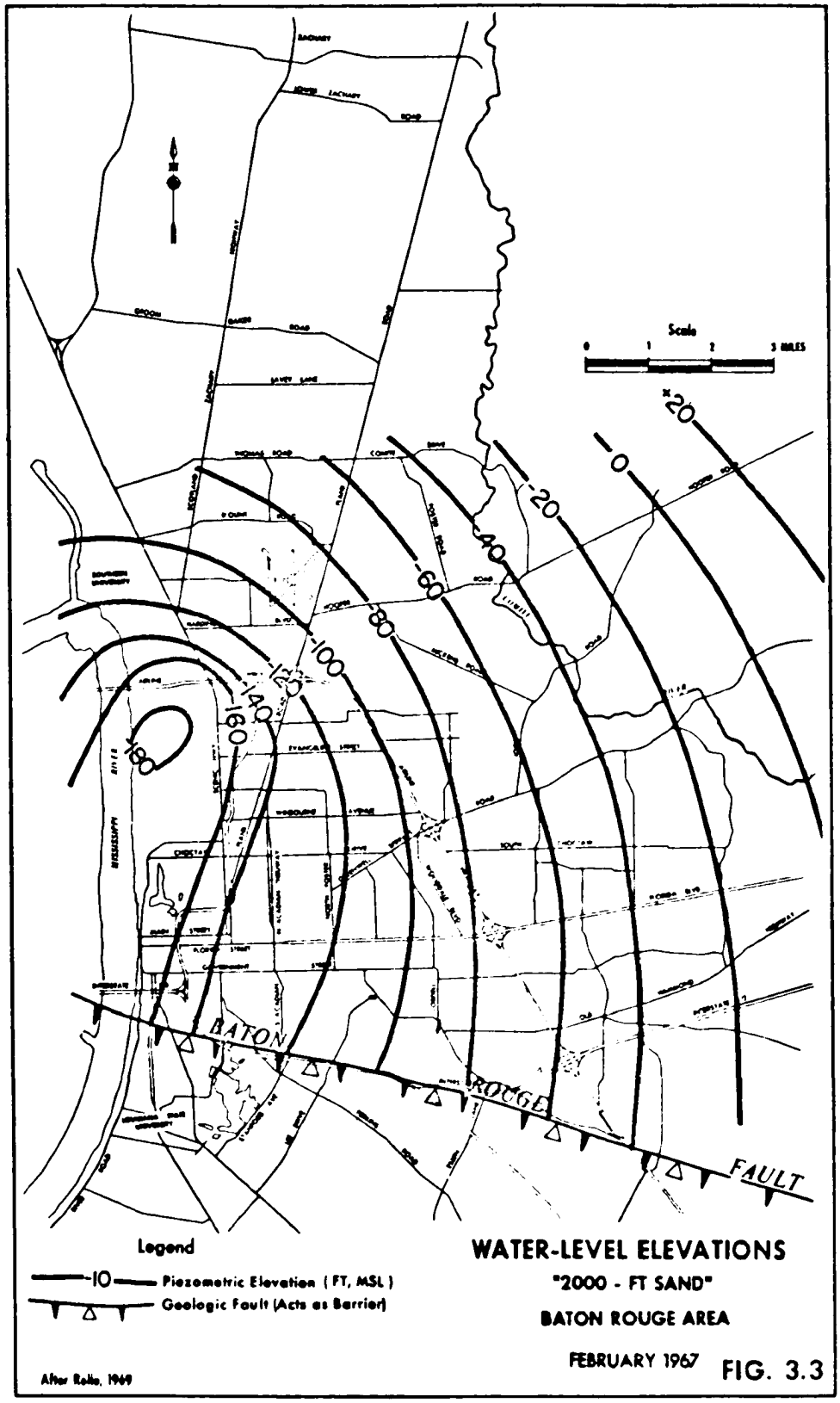


FIG. 3.3

part of East Baton Rouge Parish. The 1700 Foot sand is absent east of Baton Rouge. In the industrial area, it contains 120 feet of medium grained sand (Morgan, 1961).

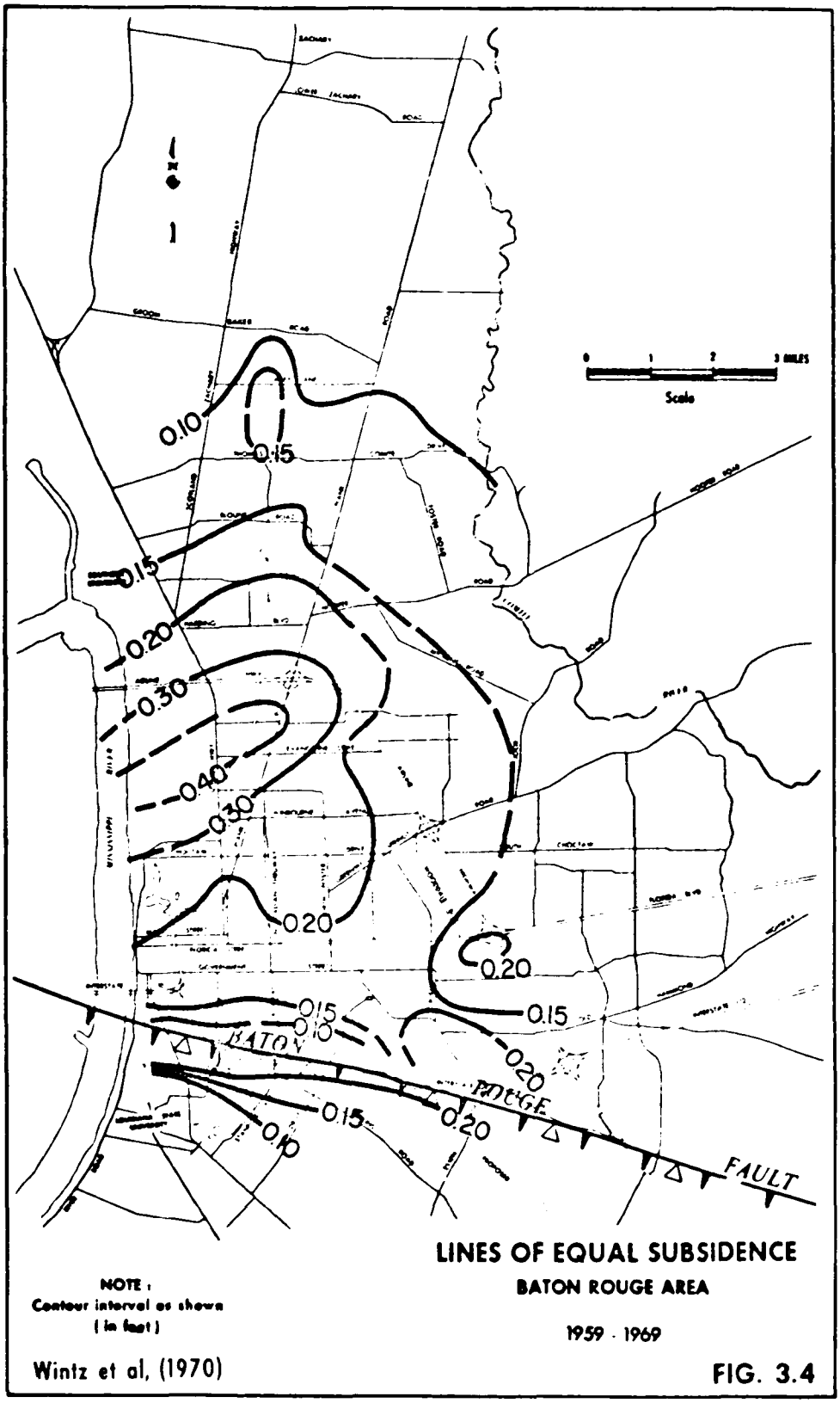
The 2000 Foot sand aquifer, one of the major aquifers in this area, yields more than 25 percent of the total ground water for industrial and public use. In the vicinity of the industrial area, the average sand thickness is about 150 feet. This aquifer apparently has no hydraulic connection with overlying or underlying aquifers, but original non-pumping levels of the 2000, 2400 and 2800 foot sands were similar and indicate a common recharge area (Morgan, 1961). The potentiometric surface of the 2000 Foot sand aquifer is shown in Figure 3-3.

The 2400 Foot sand is a very extensive aquifer, except in some areas west of the industrial center. The thickness of the sand ranges between 80 and 250 feet. In southeast Baton Rouge, it merges with the 2800 Foot sand aquifer.

The 2800 Foot sand has two units separated by clay in the industrial center. The upper unit is characterized by fresh water up to 90 feet thick, but the lower sand contains fresh to brackish water, west of the industrial center the intervening clay is absent and the ground water is generally brackish.

Land Surface Subsidence

One of the major effects of the extensive ground water offtake in the Baton Rouge area is land surface subsidence (Wintz, et al., 1970).



Industrial center is principally effected by such subsidence. The extent of the compaction and resulting subsidence is shown in Figure 3·4. Land surface subsidence is due to an increase in the rate of clay compaction caused by the withdrawal of ground water. Land surface subsidence due to ground water offtake suggests large scale addition of ground water to aquifer from the clay aquitards and lack of adequate recharge to Baton Rouge ground water system.

Between 1938 and 1964 about 0.7 foot subsidence was measured in the industrial center, while between 1959-1969, more than 0.5 foot of compaction has occurred. Kazmann (1970) estimated about 0.5 to 1.5 feet of subsidence for each 100 feet of water level decline.

CHAPTER 4

ANALYTICAL PROCEDURES AND SOURCES OF CHEMICAL DATA

Chemical analyses of the Baton Rouge ground water came from analyses by the author, the U.S. Geological Survey (Water Resources Division) and published reports on the Baton Rouge ground water (Turcan and Meyer, 1955; Morgan, 1961). The location of the sampled wells is indicated on Figure 4·1.

The chemical analyses consisted of determining the concentration of the principal ions of the ground water, namely K, Na, Ca, Mg, Cl, SO_4, HCO_3, and silica. Methods and precision of the analytical work performed by the author is shown in Table 4·1.

In addition, pH and specific conductance were measured in the laboratory. Roberson, et al, (1963) and Back (1963) have studied the difference between the field and laboratory measurement of pH, alkalinity and specific conductance. Their results indicate that pH may show about 2 units of change and field pH's are generally higher. HCO_3 and specific conductance are also effected. Some of the probable causes are namely, CO_2 evolution, precipitation of certain compounds, and temperature changes. Laboratory measurements may not represent the actual pH in the natural environment.

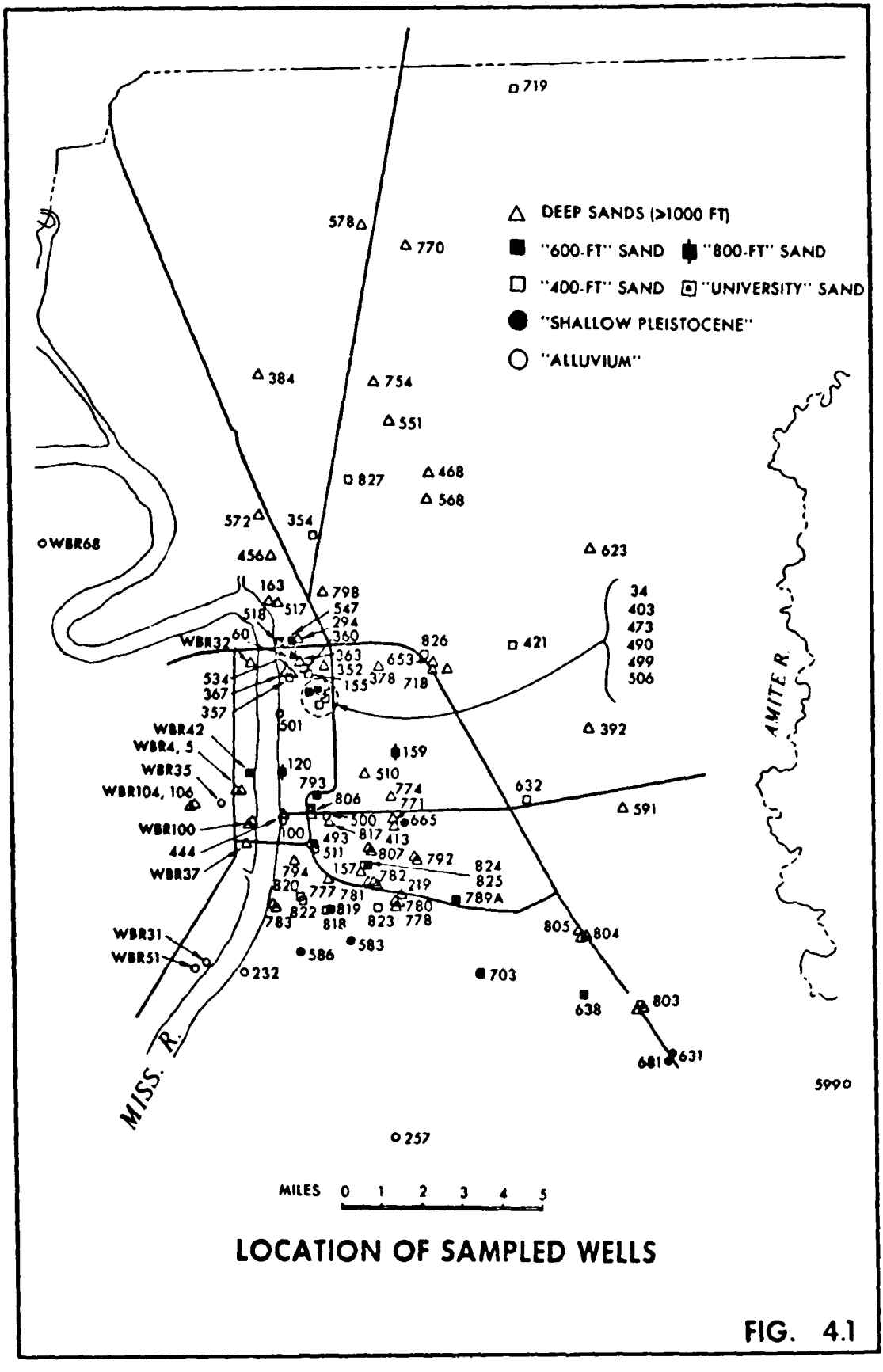


FIG. 4.1

TABLE 4·1

ANALYTICAL PROCEDURE

Chemical Constituent	Method	Precision c.v.%*	Reference
SiO_2	Colorimetric Method	5	American Public Health Association (1965)
K, Na, Ca, Mg	Atomic Absorption Spectroscopy	7	Angino and Billings (1967)
SO_4	Colorimetric Method	4.9	American Public Health Association (1965)
Cl	Specific Ion electrode	12	Orion Research Inc. (1966)
	Mercuric Nitrate	--	American Public Health Association (1965)
HCO_3	Calculated, assuming electrical neutrality, (except in a few cases)	--	
pH	pH Meter	5	Rainwater and Tatcher (1960)
Specific conductance	Conductivity Bridge	1	American Public Health Association (1965)

$$*c.v.\% = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

CHAPTER 5

CHEMICAL CHARACTERISTICS OF THE SURFACE WATERS IN THE BATON ROUGE AREA

Chemical data for calculating an average composition of the Mississippi River and the average chemical composition of the Amite-Comite river water are available in earlier records of stream gauge and surface water quality in this area (Kapustaka, 1964; Duncan, 1965). Some samples of the Amite and Comite rivers were also analyzed by the author in the course of study. The composition of the Mississippi River and Amite-Comite rivers are tabulated (Tables 5·1, 5·2). Since diluted sea water may be one of the sources of Baton Rouge water, its average composition is also considered (Goldberg, 1966, Table 5·3).

The average Amite-Comite river waters show a hydrochemical facies which can be represented as $Na > Ca > Mg:HCO_3 > Cl > SO_4$, the Mississippi River is characterized by $Ca > Na > Mg:HCO_3 > SO_4 > Cl$ and the sea water has a facies $Na > Mg:Cl$. The method for distinction of the hydrochemical facies is outlined in Chapter 6.

The $Na > Ca > Mg:HCO_3 > Cl > SO_4$ facies as shown by Amite-Comite rivers is also characterized by low total dissolved solids, compared to ground waters present in this area. All ions except K constitute more than 5 percent of the total ion concentration in the Amite-Comite rivers, while in the ground waters, generally only a few ions are abundant enough to be included in the facies designation. This water has the potential to be molded into various ground water facies known

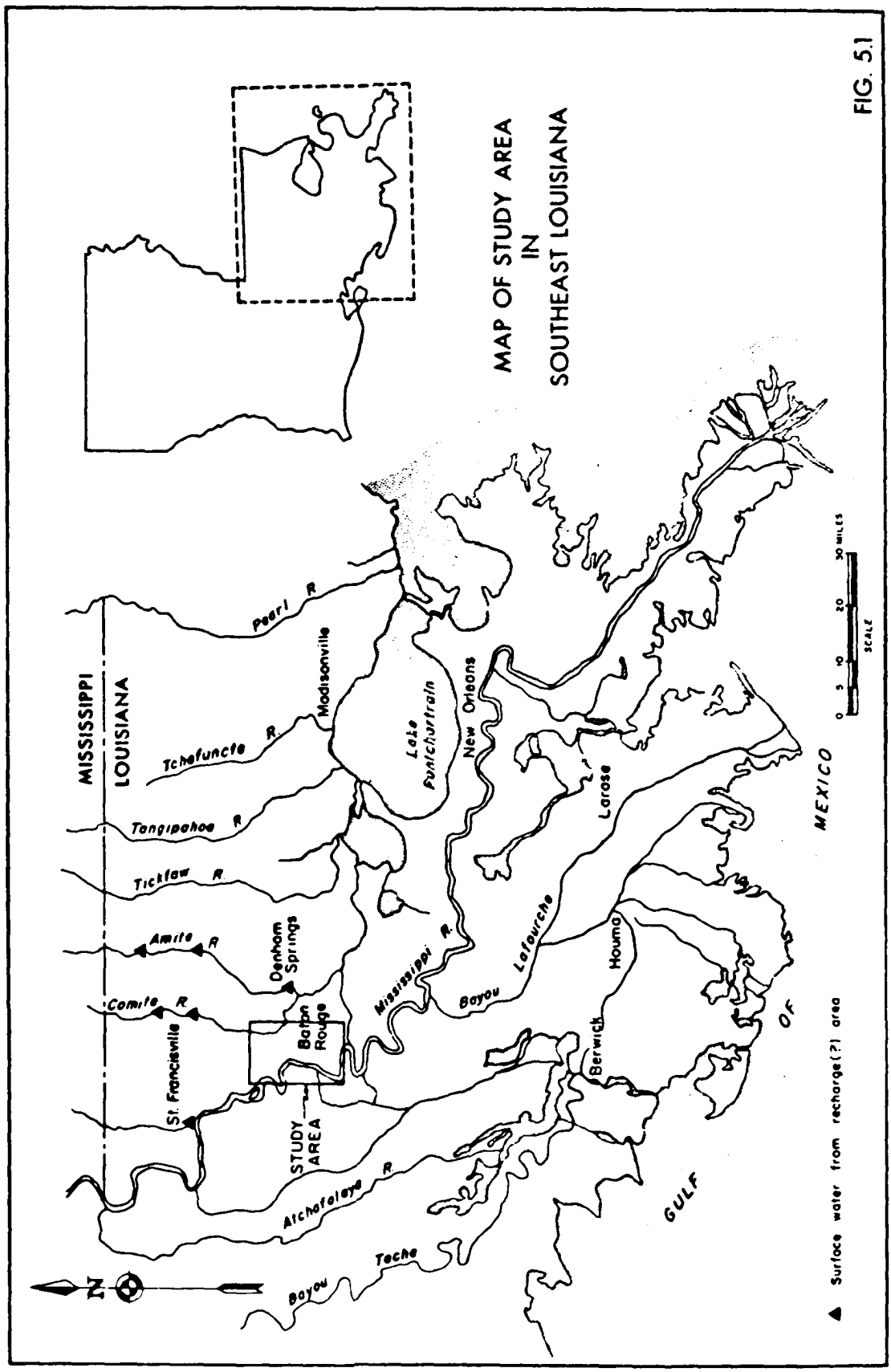


FIG. 5.1

TABLE 5·1

AVERAGE CHEMICAL COMPOSITION OF SURFACE WATERS
AROUND BATON ROUGE, LOUISIANA*
AMITE AND COMITE RIVERS

Major Ions	Mean	Standard Error	α = .05		Number of Samples	Equivalent per Million	Percent epm
			UCL**	LCL**			
SiO_2	6.8	0.6	8.03	5.56	27	--	--
Ca	2.0	0.1	2.20	1.79	28	0.10	13.15
Mg	0.6	0.0	0.6	0.6	28	0.04	5.26
Na	4.2	0.2	4.61	3.78	24	0.18	23.68
K	1.0	0.0	1.0	1.0	27	0.02	2.63
HCO_3	12.5	0.7	13.97	11.02	19	0.2	26.31
SO_4	2.8	0.6	4.03	1.56	28	0.05	6.57
Cl	6.1	0.5	7.12	5.07	28	0.17	22.36

Total Dissolved Solids: 29.7 ± 1.4

All values are in parts per million, unless otherwise indicated.

*Based on the data from samples analyzed in Geochemical Laboratory, Department of Geology, Louisiana State University, June-July 1968, and Duncan, A. C., 1965, Chemical Quality of Surface Waters of Louisiana, 1959-63, Basic Records Report No. 2, La. Dept. of Public Works, Baton Rouge, La., pp. 13-31, 35-36.

**UCL = Upper confidence limit; LCL = Lower confidence limit

TABLE 5·2

AVERAGE CHEMICAL COMPOSITION OF SURFACE WATERS
AROUND BATON ROUGE, LOUISIANA*
MISSISSIPPI RIVER

Major Ions	Mean	Standard Error	α = .05 UCL**	α = .05 LCL**	Number of Samples	Equivalent per Million	Percent epm
SiO_2	8.82	0.16	9.13	8.50	191	--	--
Ca	41.2	0.37	41.92	40.47	191	2.056	26.54
Mg	10.6	0.17	10.93	10.26	191	0.8744	11.28
Na	20.8	0.50	21.78	19.81	191	0.9051	11.68
K	2.7	0.03	2.75	2.64	191	0.0697	0.89
HCO_3	128.4	1.9	132.14	124.65	191	2.093	27.01
SO_4	49.9	0.79	51.45	48.34	191	1.038	13.40
Cl	25.2	0.5	26.18	24.21	191	0.71	9.16

Total Dissolved Solids: 237.4 ± 2.62

All values are in parts per million, unless otherwise indicated.

*Based on data from: Duncan, A. C., 1965, Chemical Quality of Surface Waters of Louisiana, 1959-63, Basic Records Reports No. 2, La. Dept. of Public Works, Baton Rouge, La., pp. 13-31, 35-36. Sample locations: Mississippi River at St. Francisville, La., and Luling Ferry, La.

** UCL = Upper confidence limit; LCL = Lower confidence limit

TABLE 5·3

AVERAGE CHEMICAL COMPOSITION OF SEA WATER*

Major Ions	ppm	epm	Percent epm
SiO_2	6	--	--
Ca	400	19.96	1.67
Mg	1,350	110.97	9.32
Na	10,500	455.7	38.30
K	380	9.69	0.81
$HCO_3 + CO_3$	158	2.52	0.21
SO_4	2,649	55.099	4.63
Cl	19,000	535.8	45.03

*Goldberg, E.D., 1966, The Oceans as a Chemical System, in The Sea, ed. M. N. Hill, John Wiley & Sons, N.Y., p. 4.

to occur in this area as a result of physico-chemical processes, as discussed in a later section.

The $Ca > Na > Mg : HCO_3 > SO_4 > Cl$ facies is characteristic of Mississippi River water. It is different from the ground waters that are known to occur in this area. Earlier authors (Morgan, 1961, Smith, 1969) have proposed a recharge from the Mississippi River. This suggestion cannot be proved chemically unless physico-chemical processes such as solution, ion exchange, mixing, etc. could be taken into consideration.

Similarly, sea water has a facies $Na > Mg : Cl$, whereas the brackish water in this area has a hydrochemical facies such as $Na > Ca : Cl > HCO_3$ or $Na : Cl > HCO_3$, hence the sea water is not similar to brackish water in their ionic composition. In a later section, it will be shown that brackish ground water is not a simple mixture of sea or estuarine water with fresh ground water.

CHAPTER 6

CHEMICAL CHARACTERISTICS OF GROUND WATER IN BATON ROUGE AREA

Introduction

The chemical composition of the ground water is neither diagnostic of a particular aquifer nor is uniform chemically. Usually, in shallow aquifers i.e. aquifers occurring less than 1000 feet, Na is a principal ion. Fresh water and brackish water both exist at varying depths.

Classification of the Baton Rouge Ground Water

Chemical variability of the ground water is evident from the plot of chemical composition on the Piper's diagram (Piper, 1944), Figure 6·1. The chemical composition of the ground waters are presented in Appendix A. Two principal types of ground water can be recognized: (i) Type I, Chloride waters, where the Cl ion is the dominant anion. This is characteristic of the brackish water, and (ii) Type II, Bicarbonate waters, where HCO_3 ion is the principal anion. Type II can be further distinguished on the basis of the dominant cation into two subtypes, (a) Type IIA; Na is the dominant cation and (b) Type IIB, Ca and Mg are the dominant cations. This classification is shown schematically in Figure 6·2.

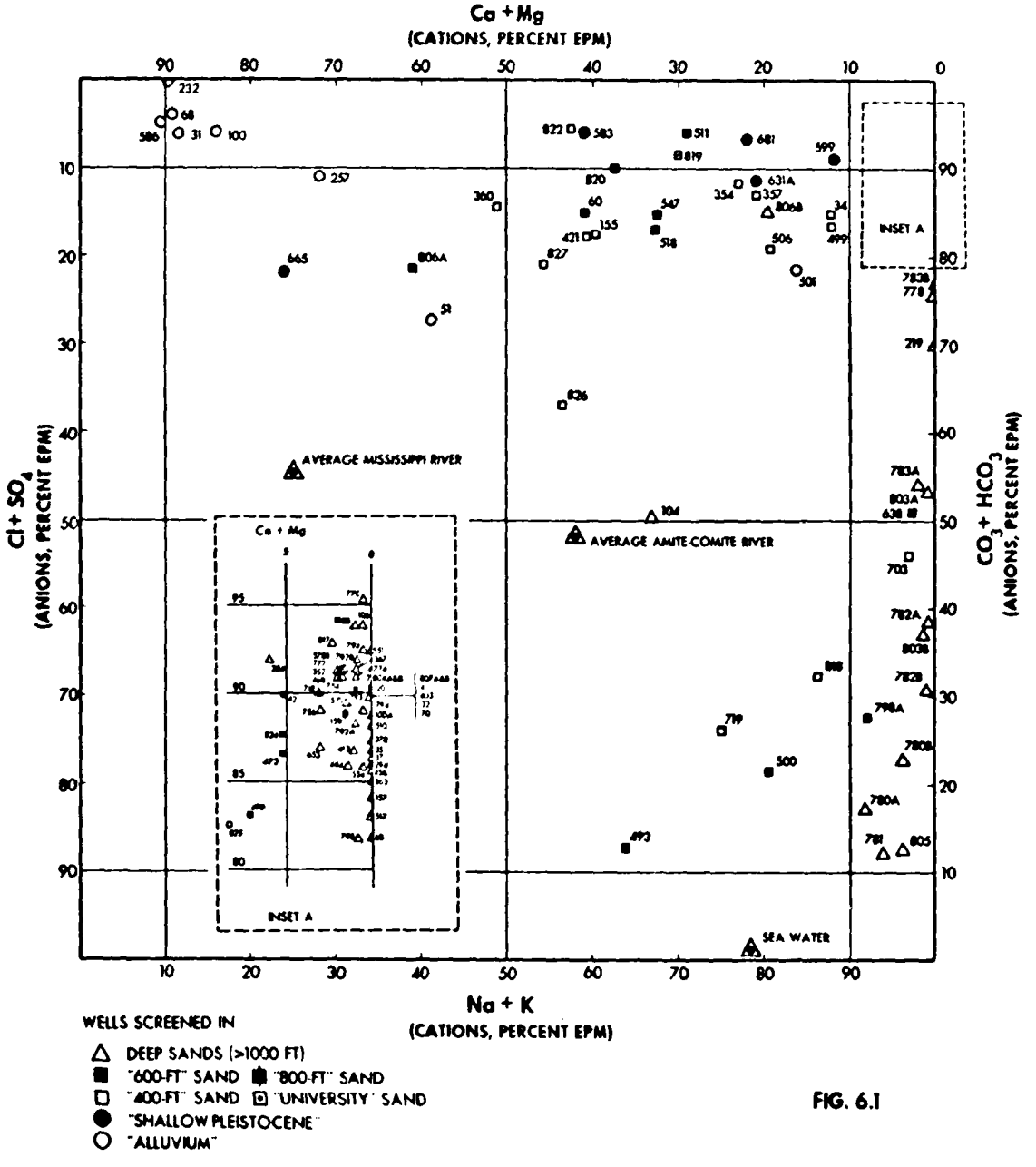


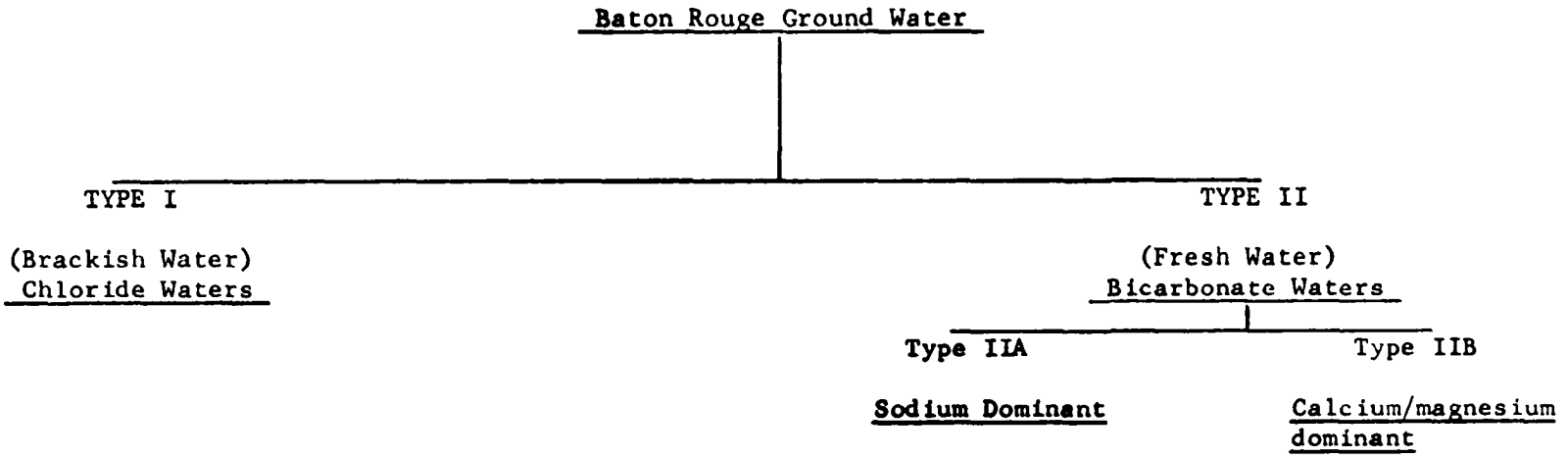
FIG. 6.1

MODIFIED PIPER'S DIAGRAM
SHOWING
CHEMICAL CHARACTERISTICS OF GROUND WATER

BATON ROUGE, LOUISIANA

FIGURE 6·2

CLASSIFICATION OF THE BATON ROUGE GROUND WATER*



* Ground Water of intermediate character between the types have not been shown here.

Chloride Water (Type I)

Usually the relative ionic abundance of Type I water is $Na > Ca > Mg > K$ and $Cl > HCO_3 > SO_4$ with more than 1500 parts per million of total dissolved solids. However, some of the dominant Cl ground waters studied contain less than 1500 ppm of dissolved solids due to dilution.

The main differences within the group are due to changes in the amount of the total dissolved solids, the Na/Ca ratio and the Cl concentration. All the ground water occurring south of the Baton Rouge fault below 500 feet are generally Type I waters. Brackish water (Type I) also occurs in some wells north of the Baton Rouge fault (well EB 123, 500, 493, 806A) in the proximity of the industrial area. Any waters with more than 30 ppm Cl are thought to result from the dilution of brackish waters, because the surface waters do not exceed 25 ppm Cl.

Bicarbonate Water (Type II)

All ground water other than Type I, in the Baton Rouge area is Type II. The relative abundance of the ions are: $Na > Ca > Mg > K$ and $HCO_3 > SO_4 > Cl$ for subtype IIA and $Ca > Mg > Na > K$ and $HCO_3 > SO_4 > Cl$ for subtype IIB. The bicarbonate waters (Type II) form a large complex group which occur in all the aquifers to a depth of about 3000 feet. The major difference between the two subtypes are the Na/Ca and Na/Mg ratios. Subtype IIA has high Na/Ca (126-394) and Na/Mg (347-1649) ratios, while subtype IIB has low Na/Ca (0.14-0.58) and low Na/Mg (0.17-0.58) epm ratios. The chemical compositions are shown in Appendix A. Subtype IIB is generally confined to the Alluvial, University

sand and shallow Pleistocene aquifers, while deeper aquifers generally contain subtype IIA ground waters.

The K content of subtype IIA waters range between 0.2 and 7.5 ppm, but averages about 2 ppm. The Na content is comparatively higher, averaging 58 ppm and ranging between 18 and 120 ppm. The Ca and Mg content is generally lower except where solution of carbonate minerals might have taken place. Calcium ranges between 0 and 4.0 ppm, the Mg content varies between 0 and 2 ppm. The cation ratios, Na/Ca and Na/Mg, vary from sample to sample, sometimes the Ca/Mg ratio also changes. The Cl content averages 10 ppm, and ranges between 2 and 25 ppm. The average SO_4 concentration is about 10 ppm, while HCO_3 ranges between 77 and 412 ppm. The silica content in the ground water is almost constant at 30 ppm. The total dissolved solids are low.

Because of low Na/Ca and Na/Mg, the type IIB ratios were distinguished from the type IIA bicarbonate waters. The Na/Ca (epm) ratios for type IIB are generally between 0.14-0.58 and the Na/Mg (epm) ratio is usually 0.17-0.58; these ratios are extremely low compared to type IIA ground waters. The Ca content in Type IIB is between 9 and 129 ppm, while Mg content varies between 1.5 and 39 ppm. The HCO_3 is also a principal anion in type IIB.

Hydrochemical Facies of the Ground Water

The concept of facies in hydrochemistry is used to genetically relate water composition to the natural environment. According to Back (1960, p. 88), the hydrochemical facies "reflects the response

of chemical processes in a lithologic framework and the pattern of water flow in it". Back and Hanshaw (1965, p. 74) state that "the primary controls on the dissolved solid contents of ground water are (i) original chemical character of the ground water, as it enters the zone of saturation; (ii) distribution, solubility, exchange capacity and exchange selectivity of the minerals in deposits; (iii) porosity and permeability of the rocks; (iv) flow path of the water".

In addition to natural hydraulic gradient, the flow path of the ground water could be effected by (a) localized offtake of ground water, (b) compaction of fine grained deposits forming aquitards, (c) structural controls such as faults, and (d) stratigraphic discontinuities.

Mapping of the Hydrochemical Facies

Hydrochemical facies of ground water have been mapped previously by Back (1960, 1961 and 1966) in the Atlantic Coastal Plain, based upon the criteria outlined in the Table 6·1a. The same criteria were applied by Morgan and Winner (1962) to map hydrochemical facies of the 400 and 600 foot sand aquifer in the Baton Rouge area. Criteria of Back (Table 6·1b) were not used in the present study, because (i) the ground water composition is gradational, whereas hydrochemical facies boundaries are abrupt leading to abrupt changes which may not be the case in nature. (ii) ions are grouped in pairs so that facies label may not exactly fit the actual composition. For example, $HCO_3 - Cl + SO_4$ may be a facies for a water which has a relative order of ionic abundance as $HCO_3 > SO_4 > Cl$ or $HCO_3 > Cl > SO_4$. The same

TABLE 6·1 a

BACK'S CLASSIFICATION OF HYDROCHEMICAL FACIES*

Hydrochemical Facies	Chemical Constituents (percent)			
	Ca + Mg	Na + K	$HCO_3 + CO_3$	$Cl + SO_4$
Cation Facies				
Calcium-magnesium	90 - 100	0 < 10	--	--
Calcium-sodium	50 - 90	10 < 50	--	--
Sodium-calcium	10 - 50	50 < 90	--	--
Sodium	0 - 10	90 - 100	--	--
Anion Facies				
Bicarbonate	--	--	90 - 100	0 < 10
Bicarbonate-Chloride-sulfate	--	--	50 - 90	10 < 50
Chloride-sulfate-Bicarbonate	--	--	10 - 50	50 < 90
Chloride-Sulfate	-	--	0 - 10	90 - 100

* Back, 1961

is true for a cation facies, for example, Ca-Na facies may be the facies given for a ground water which has a relative order of cation abundance as Mg > Ca > Na or Ca > Mg > Na.

In order to define the hydrochemical facies of the ground water samples, the individual chemical analyses containing K, Na, Ca, Mg, Cl, SO_4 and HCO_3 have been converted from parts per million to equivalents per million, by multiplying parts per million with the reciprocal of the equivalent weight of the individual ion. The equivalence values thus obtained, may be converted to percent equivalent values (Appendix A, Table A-2 and A-3). Hydrochemical facies are then determined by considering the ion percentages in order of relative abundance of cation and anions, neglecting ions which constitute less than 5 percent and listing both cation and anion facies together to show the water composition by principal ions.

In the hydrochemical facies, for example, the term Na > Ca: HCO_3 facies indicate that Na, Ca and HCO_3 constitute more than 5 percent of all ions individually, while Mg, K, SO_4 and Cl are less than 5 percent and are therefore, considered insignificant. Na is the dominant ion among the cations, while HCO_3 is the principal ion among the anions. Ca constitutes more than 5 percent of all the ions and is therefore included, but is lower than Na. This approach in the description of the hydrochemical facies has been useful in distinguishing the general chemical character of vastly varying ground waters.

The use of cation and anion facies together is particularly useful where two genetically different ground water can be grouped

under Na facies, one may be fresh (Bicarbonate water, Type II), and the other is brackish water (Chloride water, Type I). Similarly, there are two types of water which can be grouped under HCO_3 facies, one is Na dominant (Type IIA), the other is Ca and Mg dominant (Type IIB).

The Baton Rouge aquifer system consists of a complex sand-clay sequence and the individual aquifers are named after the approximate depth of their occurrence, such as 400 foot sand, 600 foot sand, 800 foot sand, etc. (Turcan and Meyer, 1955). In addition to these aquifers, there are lenses of sand, both large and small, which may not be of any use as a source of ground water. Where a number of stratigraphic units are involved, a hydrochemical facies plot based upon depth is an effective method for showing facies distribution in the aquifers (Silin-Bekchurin, 1958, p. 85). The merging of different aquifers, such as Alluvial, University, 400 and 600 foot sand aquifers (Smith, 1969), and the 600 foot sand with 800 foot sand, the 1000 foot sand and 1200 foot sand, the 1500 foot sand and 1700 foot sand, etc. (Morgan, 1961) suggests a great deal of interchange between the units and the necessity of mapping hydrochemical facies with respect to depth.

Distribution of the Hydrochemical Facies

The hydrochemical facies distribution for certain depth intervals are illustrated in Figure 6·3. The intervals mapped are 0-500 feet (Figure 6·3A), 500-1000 feet (Figure 6·3B) and 1000-2800 feet (Figure 6·3C). In addition, relation of the facies with stratigraphy and structure is illustrated in Figure 6·4 and 6·5. However,

the distinction of three depth intervals have been rather arbitrary, and is not based upon any hydrologic or geologic consideration.

(1) Hydrochemical Facies Distribution in the Depth Interval 0-500 Feet

The depth interval 0-500 feet in most of the area includes the Alluvial aquifer, University sand and 400 Foot sand aquifers. The facies distribution is shown in Figure 6·3A.

Although Na is the dominant cation, Ca and Mg are also significant, forming facies such as $Ca > Mg:HCO_3$, $Na > Ca:HCO_3$, etc. In some ground water samples with low total dissolved solids (e.g. EB421, 827, 826) the hydrochemical facies is especially complex because most of the ions are present in amounts greater than 5 percent. Ground waters with Ca and Mg as the dominant cations occur in the Alluvial and shallow Pleistocene aquifers to the south. Two wells located in the industrial center, show Na as the only cation in the hydrochemical facies.

(2) Hydrochemical Facies in the Depth Interval 500-1000 Feet

This depth interval includes two important aquifers, the 600 Foot and 800 Foot sands. The hydrochemical facies in this depth interval (Figure 6·3B) is characterized by the following:

(a) The Baton Rouge fault appears to influence the facies distribution. Brackish waters are localized near the fault and there is a difference in the facies of the waters at similar depths on opposite sides of the fault.

(b) In the central part of the study area, the waters have a simple facies characterization. Na and HCO_3 ions are most abundant. It will be shown in a later section that the presence of the $Na:HCO_3$

facies in this zone is related to clay compaction.

(3) Hydrochemical Facies in the depth Interval 1000-2800 Feet

This interval includes seven major fresh water aquifers, the 1000, 1200, 1500, 1700, 2000, 2400, and 2800 Foot sands. Some of the important features of this depth zone are revealed in Figure 6·3C;

(a) Practically all the ground water in this depth interval belongs to the Na:HCO_3 facies. Some variations do exist, but the variations appear to be localized.

(b) South of the Baton Rouge fault, all ground water is chloride rich (Type I).

(c) Some wells (EB 781, 782A and 782B) just north of the Baton Rouge fault appears to have been contaminated by Chloride water (Type I). Rollo (1969) suggests Cl comes from leakage across the barrier formed by the fault.

The hydrochemical facies distribution has also been shown with respect to the stratigraphic and structural framework (Figure 6·4 and Figure 6·5). These geologic sections summarize the results of the previous hydrogeologic work (Kazmann, 1970). The distribution of the chemical facies is similar to that discussed with respect to depth (Figure 6·3 A, B, C). The following features may be noted:

(a) Shallow aquifers are characterized by complex ionic facies where more than one cation, and anion, are significant constituents of the ground water. The ions do not show any relation to stratigraphic or structural features. For example, well EB 820, south of the Baton Rouge fault and well EB 511, north of fault, in

the University sand have the same facies (Figure 6·4).

(b) Chloride rich facies are restricted to the south side of the Baton Rouge fault and its vicinity. Deeper sands sometimes contain significant amounts of Cl north of the fault (EB 806B, EB 534) (Figure 6·4).

(c) Na:HCO_3 facies predominates with depth, (Figure 6·4 and Figure 6·5).

(d) The industrial area is characterized by the Na:HCO_3 facies in the 400 and 600 foot sands, at higher elevations than generally seen elsewhere. (Figure 6·4).

REGRESSION ANALYSES

A more quantitative expression of the relationships developed above was deemed prerequisite to a discussion on the origin of the chemical characteristics of the ground waters. A multiple regression analysis program developed by Dr. P.E. Schilling of the Department of Experimental Statistics at Louisiana State University was utilized to study the spatial distribution of the ions with respect to: (i) The supposed recharge area to the north of Baton Rouge (Morgan, 1961; Parsons, 1967), (ii) The Mississippi River (Smith, 1969); (iii) The area of extensive offtake and maximum land surface subsidence (Rollo, 1969; Wintz, et al,1970), and (iv) The depth to the sampled interval. In the analyses, linear, quadratic and cubic relationships between the independent variables and the ion percentages were evaluated in a stepwise fashion. As a result the

TABLE 6·1b

Partial Regression Coefficients in the Multiple Regression Equation for All the Ground Water(Excluding Brackish Waters)

		Distance from the Rechrage Area			Distance From Mississippi River			Distance From Industrial Area			Depth			
	bo	L	Q	C	L	Q	C	L	Q	C	L	Q	C	R
Y_1(K)	2.194	-0.044	ns	ns	ns	ns	ns	-0.057	ns	ns	$4.13\ 10^{-4}$	ns	ns	0.558
Y_2(Na)	23.054	ns	ns	ns	ns	0.179	ns	-1.917	ns	ns	$3.27\ 10^{-2}$	$-7.99\ 10^{-6}$	ns	0.818
Y_3(Ca)	-5.226	4.895	-0.300	$5.16\ 10^{-3}$	-2.173	ns	ns	2.535	ns	ns	$-2.10\ 10^{-2}$	$5.24\ 10^{-6}$	ns	0.811
Y_4(Mg)	8.669	ns	ns	ns	ns	$-5.77\ 10^{-2}$	ns	$6.01\ 10^{-1}$	ns	ns	$-9.84\ 10^{-3}$	$2.32\ 10^{-6}$	ns	0.752
Y_5(Cl)	3.481	ns	ns	ns	ns	$1.45\ 10^{-1}$	$-2.17\ 10^{-2}$	2.343	$-6.661 10^{-1}$	$4.69\ 10^{-2}$	$01.60\ 10^{-3}$	ns	ns	0.718
Y_6(SO_4)	-0.341	ns	ns	ns	ns	$7.32\ 10^{-2}$	$-4.84\ 10^{-3}$	$5.89\ 10^{-1}$	$-1.49\ 10^{-1}$	$7.05\ 10^{-3}$	$7.36\ 10^{-3}$	$-4.70\ 10^{-6}$	$8.28\ 10^{-10}$	0.586
Y_7(HCO_3)	41.57	ns	ns	ns	ns	ns	$1.37\ 10^{-2}$	ns	$2.32\ 10^{-1}$	$2.78\ 10^{-2}$	ns	ns	ns	0.367

Note: L = Linear
Q = Quadratic
C = Cubic
ns = not significant

insignificant variables are eliminated from the equation, leaving only the terms which have a significant effect upon the ionic abundance (ion epm percent). The partial regression coefficients and the multiple regression coefficient (R) for each ion are tabulated (Table 6·1b). All ground waters with more than 30 parts per million Cl content have been excluded from the regression analyses.

The results of this analysis produced some significant relationships which are summarized below:

1. Potassium: The calculated partial regression coefficients suggest a relationship between K abundance and three of the factors, but the values are so small and R is less than 0.6, so it is a questionable association.
2. Sodium: The abundance of this ion is inversely related with distance from the industrial area and directly related to increased distance from the Mississippi River. Depth also influences its distribution.
3. Calcium: The distribution of calcium is the mirror image of the sodium distribution. In addition, distance from the recharge area is important.
4. Magnesium: The distribution of magnesium is inversely related to the sodium distribution.
5. Chloride: Three of the factors influence the chloride ion's distribution, but its small overall abundance makes the relationships less important.
6. Sulfate and Bicarbonate: The distribution of these anions is apparently not related to the chosen factors.

TABLE 6-2

CORRELATION COEEFICIENT FOR THE SEVEN PRINCIPAL CHEMICAL COMPONENTS OF THE GROUND WATER IN BATON ROUGE AREA

	K	Na	Ca	Mg	Cl	SO_4	HCO_3
K		-0.302	0.280	0.236	0.156	-0.033	-0.158
Na			-0.974	-0.931	-0.311	0.315	0.091
Ca				0.848	0.227	0.334	0.070
Mg					0.403	-0.292	-0.133
Cl						-0.175	-0.512
SO_4							-0.049
HCO_3							

In addition to the analysis of the ionic distribution, correlation coefficients were calculated to assess ionic interactions. These aspects of the results are reported in Table 6·2, and are especially important:

(a) There is a definite negative correlation between Na and Ca and Na and Mg, and a positive correlation between Ca and Mg.

(b) SO_4 and HCO_3 do not show a significant interaction.

(c) There is little or no relationship between anions and cations.

CHAPTER 7

ORIGIN OF THE GROUND WATER

Introduction

The chemical evolution of the Baton Rouge ground water is complex due to the presence of different types of water and their variable interaction with the environment. The chemical character may be the result of a number of physico-chemical processes, acting individually or collectively to produce the observed variations. Some processes leave their mark, while others may remain obscure. In the present discussion four principal mechanisms will be considered in the light of available data. The principal mechanisms which may have affected the chemistry of ground water in this area are, (i) mixing of waters, (ii) ion exchange (iii) filtration of dissolved constituents, due to compaction, and (iv) mineral solubility.

Mixing of Waters

Mixing of waters is a common phenomenon in the natural environment. It is difficult to obtain an ideal mixture, because mixing is usually accompanied by a number of other physico-chemical processes. Mixing may involve brackish and fresh waters (Cl water with HCO_3 water) or, fresh water being further diluted by rain water, or two fresh waters. Mixing or dilution are usually interchangeable

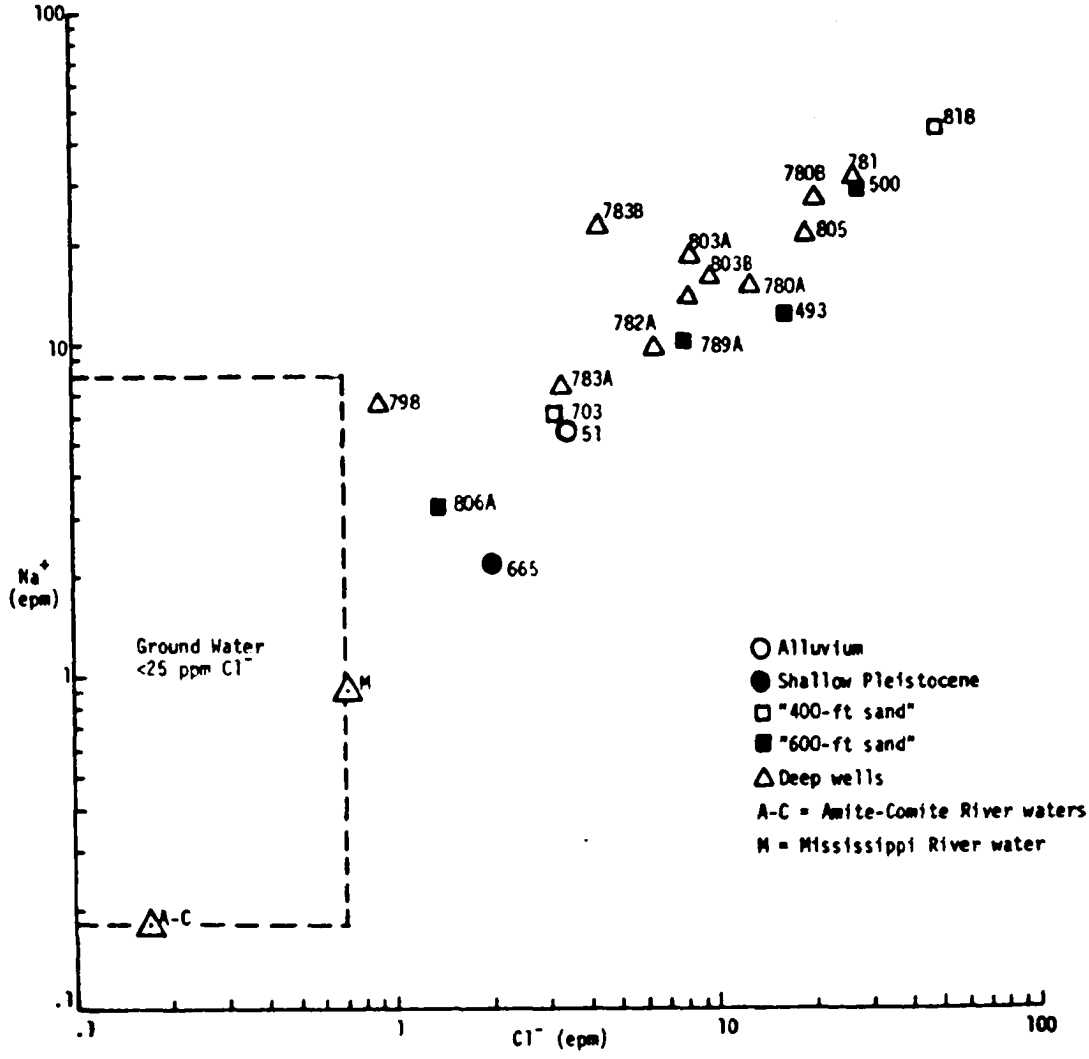


Figure 7.1 Sodium-Chloride Relation for the type I Ground Water and Some Affected Fresh Water Samples.

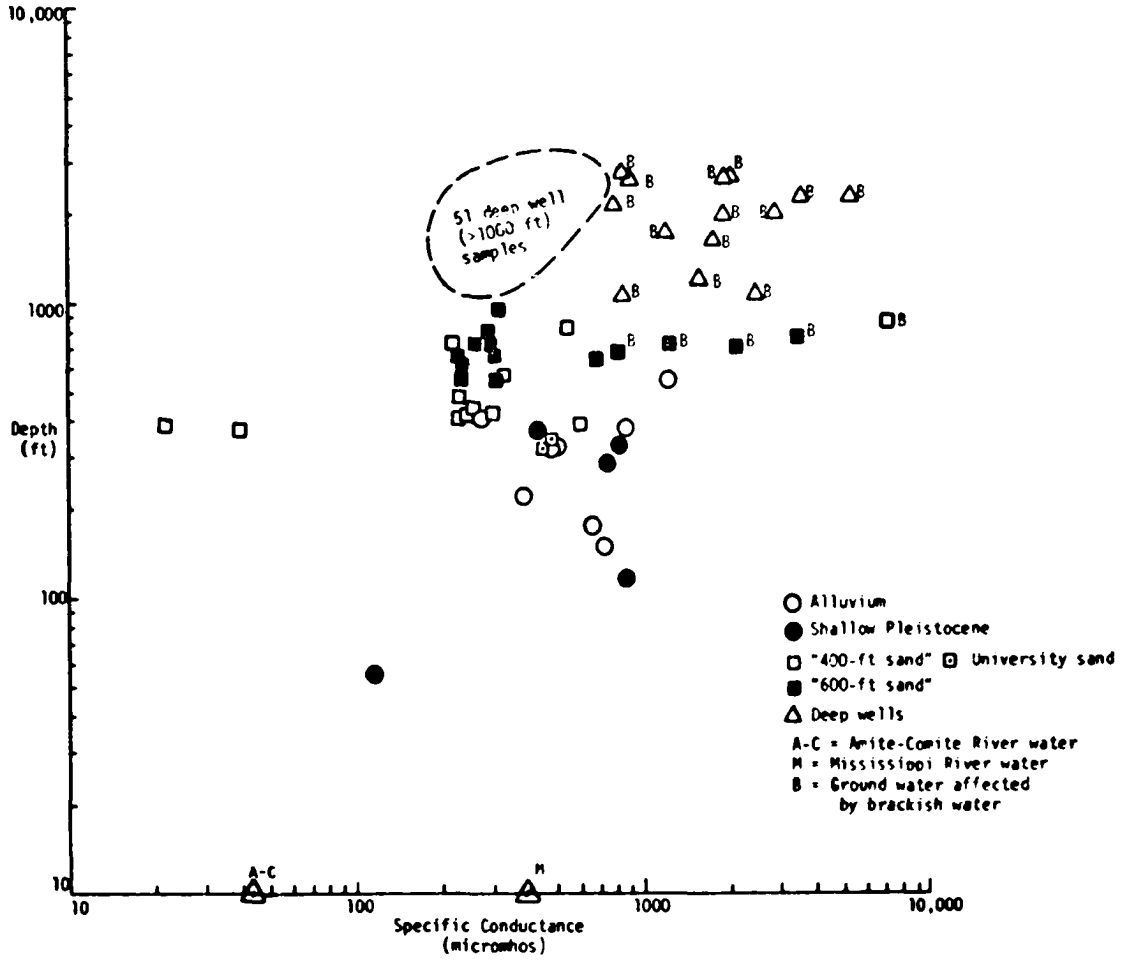


Figure 7.2 Depth-Specific Conductance Relation among the Ground Water Samples.

terms. McKinnel (1958) and Piper (1953) have developed methods to estimate quantitively the proportion of end members. These methods are of limited use in many aquifers because of the interference of other processes on ionic abundance.

In the Baton Rouge ground waters, mixing (or dilution) is commonly observed in both genetic types. In type I (Cl water), the variation in salinity and Cl concentration is probably due to the mixing of fresh and brackish waters. Figure 7·1 shows the relationship between Na and Cl in Type I waters that is suggestive of mixing. An increase in Cl is usually accompanied by Na, and there is all degrees of variation.

The continuous variation in the specific conductance (Figure 7·2 is also suggestive of mixing. Especially in the brackish waters there is a complete gradation within one aquifer. The water levels in some wells containing brackish waters have been shown to fluctuate with Mississippi River stages (Smith, 1969). Similarly, increases in Cl content of various fresh water wells have been continuous (Kazmann, 1970). The gradational nature of these changes suggests the importance of mixing.

Type IIA (HCO_3 water with Na dominant) waters in the north of the industrial center (EB 421, 826, 827) have low specific conductances and the hydrochemical facies of the water samples is similar to that shown by average Amite-Comite river (Figure 7·1), suggesting infiltration on local basis and mixing. The fluctuations of the water levels

in University sand, and 400-600 Foot sand, containing Type II with Mississippi River suggests mixing. Multiple regression analyses (Table 6·1) suggests Mississippi River to be an important factor in controlling the ion abundance for all the bicarbonate waters (Type II).

In type IIB (HCO_3 water with Ca and Mg dominant), the mixing is important. Morgan (1961) has shown hydraulic connection between the Mississippi River and wells located in the Alluvium of the Mississippi River. Present studies indicated that all ion except Ca, Mg and HCO_3 are lower than those which occur in the average Mississippi River water, which means dilution of Mississippi River water may have taken place, along with solution of carbonate minerals containing Ca and Mg.

There are also some analyses which suggest local infiltration and mixing. Two wells in the 400 Foot sand have a specific conductance very close to that of the Amite River. A large number of wells have a specific conductance like the Mississippi River. In addition, the dependence of ionic abundance on distance from the Mississippi River may confirm its role as a principal source.

ION EXCHANGE

Ion exchange as a process of water softening is well known. Recent studies suggest ion exchange is a principal mechanism in the development of Na rich waters. Foster (1950) suggested this mechanism for the origin of Na rich ground waters in the Gulf Coastal Plain.

Others who used the ion exchange mechanism to account for the presence of sodium in fresh waters were Bell and Nyman (1968) in the Memphis, Tennessee area, Macley and Winter (1967) in Minnesota, and John (1968) in Australia.

Ion exchange mainly takes place in the clay minerals in an aquifer. The ion exchange sites occur in a number of ways, (Grim, 1968, p. 193-194); (i) broken bonds around the edges of the structural units of the clay; (ii) removal of hydrogen from an exposed hydroxyl group; (iii) removal of the structural cations, or (iv) substitution of low valence cations for higher valence ones in the clay structure. The exchange site in the kaolinites mainly occurs by (i) and (ii), the exchange site in illite occurs by (i), (ii), (iv), while in montmorillonite, the ion exchange is mainly due to (iv). The clays exhibit preference for one ion over another. The selectivity is due to differences in charge, atomic number, type of clay, solution composition and concentration. Divalent cations are generally preferred over monovalent cations at the exchange sites, provided the chemical activity of the ions in solution is similar. Exchangeable Na should be replaced by Ca and Mg as predicted by this reaction.

The chloride rich waters (Type I) do not show a direct indication of ion exchange. Ion exchange is probably important in the bicarbonate waters (Type II), where negative correlation coefficients between Ca and Na, and Mg and Na are very high (Table 6·2). Figure 7·3 shows the relation between Ca and Na in all samples. The increase in the Na/Ca ratio with depth for Type II waters is further evidence for ion exchange.

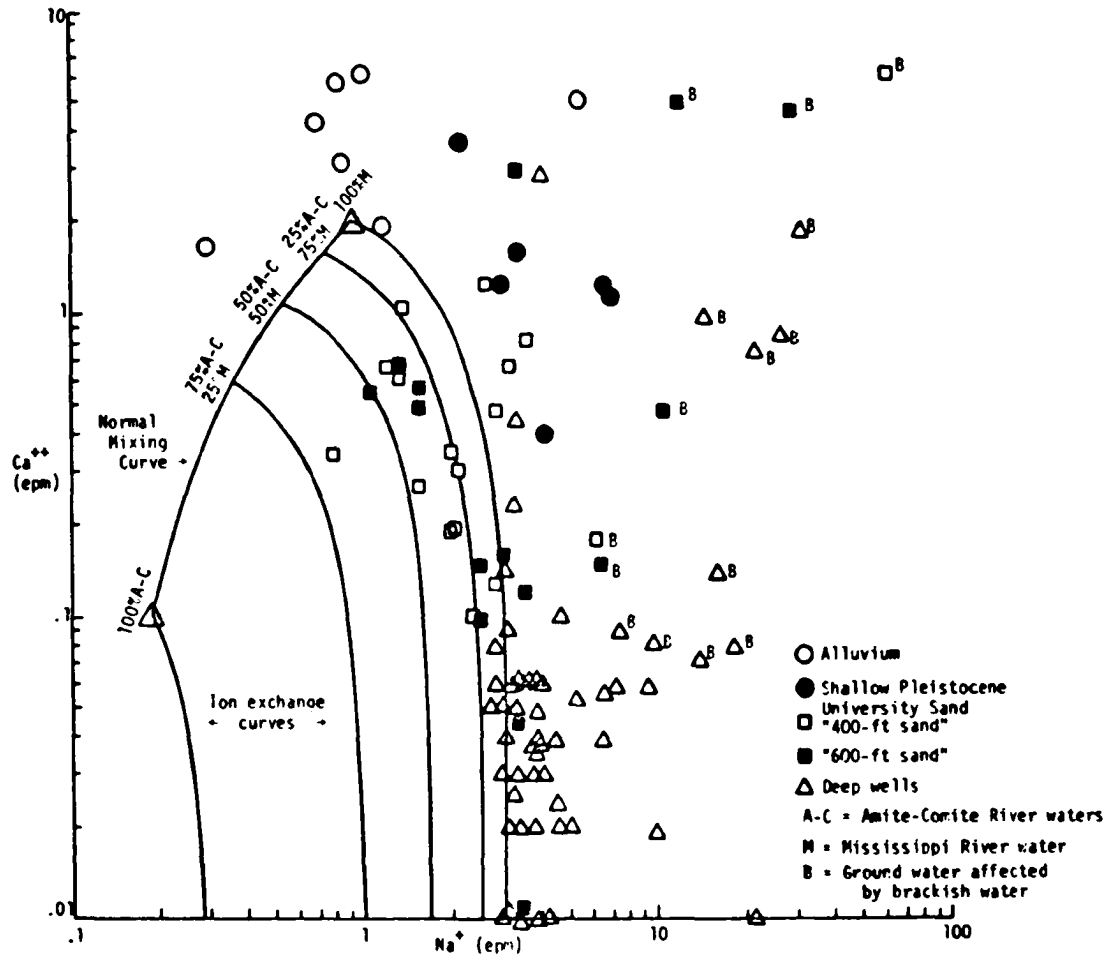


Figure 7.3 The Sodium-Calcium Relation among the Ground Water Samples, Including a mixing curve of Mississippi River and Amite-Comite River waters, and ion exchange curves for the mixture.

A visual comparison of the dependence of Ca and Na on mixing and ion exchange is afforded by Figure 7·3. A large number of the shallower wells have a composition which suggests that they are approximately 75-25 mixtures of Mississippi and Amite River waters depleted in Ca by ion exchange. The brackish water samples all contain more Ca and Na than the Mississippi River waters and do not appear to be related to ion exchange paths. The deeper water samples look like they could have originated from ion exchange modified mixtures of the two fresh surface waters, but contain excess Na.

FILTRATION OF DISSOLVED CONSTITUENTS

Chemical changes in ground water may also take place due to filtration through compacted clays which act as semi-permeable membranes. The clays allow the passage of certain ions while retarding the movement of others. Reviews on this mechanism in relation to natural environment are available (White, 1965; Berry, 1969; Chilingarian and Reike, 1969). Membrane filtration produces excess Na and a positive electrical potential on the effluent side of the membrane. Adjustment to this potential can be accomplished by the migration of H into the clay. This can change the ion exchange characteristics of the materials as well as dissolve any carbonate minerals on the input side of the membrane. The neutral H_2CO_3 molecule is the most likely dissolved species to pass through the charged membrane.

The extent of land surface subsidence in the Baton Rouge (Figure 3·4) area has been shown by Winta, et al, (1970). Maximum

land subsidence (industrial center) is coincident with the zone of extensive pumping (Rollo, 1969), as shown in Figure 3·1, 3·2 and 3·3. As the clays are compacted to bring about subsidence, they are progressively dewatered and begin to behave as semi-permeable membranes. The presence of the Na:HCO_3 facies at shallower levels in the area of extensive pumping and the dependence of ionic abundance on distance from the center of this area (Table 6·1) support the contention that some of the waters in the Baton Rouge region have been derived by membrane filtration. The Na:HCO_3 water could not have been derived from deeper sands because the potentiometric levels are lower at depth. The positive dependence of Na on depth is additional support for this hypothesis.

MINERAL SOLUBILITY

The chemistry of ground water can be greatly influenced by mineral-water reactions. The chemical changes due to mineral solubility would produce a dependency in cation and anion abundances. The ionic strength of the ground waters ought to be related to the degree of saturation of the waters with respect to the minerals present. The degree of saturation with respect to calcite and dolomite was assessed for each by the calculation of their respective ΔK's. The method used and the results are included in Appendices C and B, and Table B-2, respectively. Negative values indicate the solutions are undersaturated with respect to the mineral.

All but 10 of the samples are undersaturated with respect

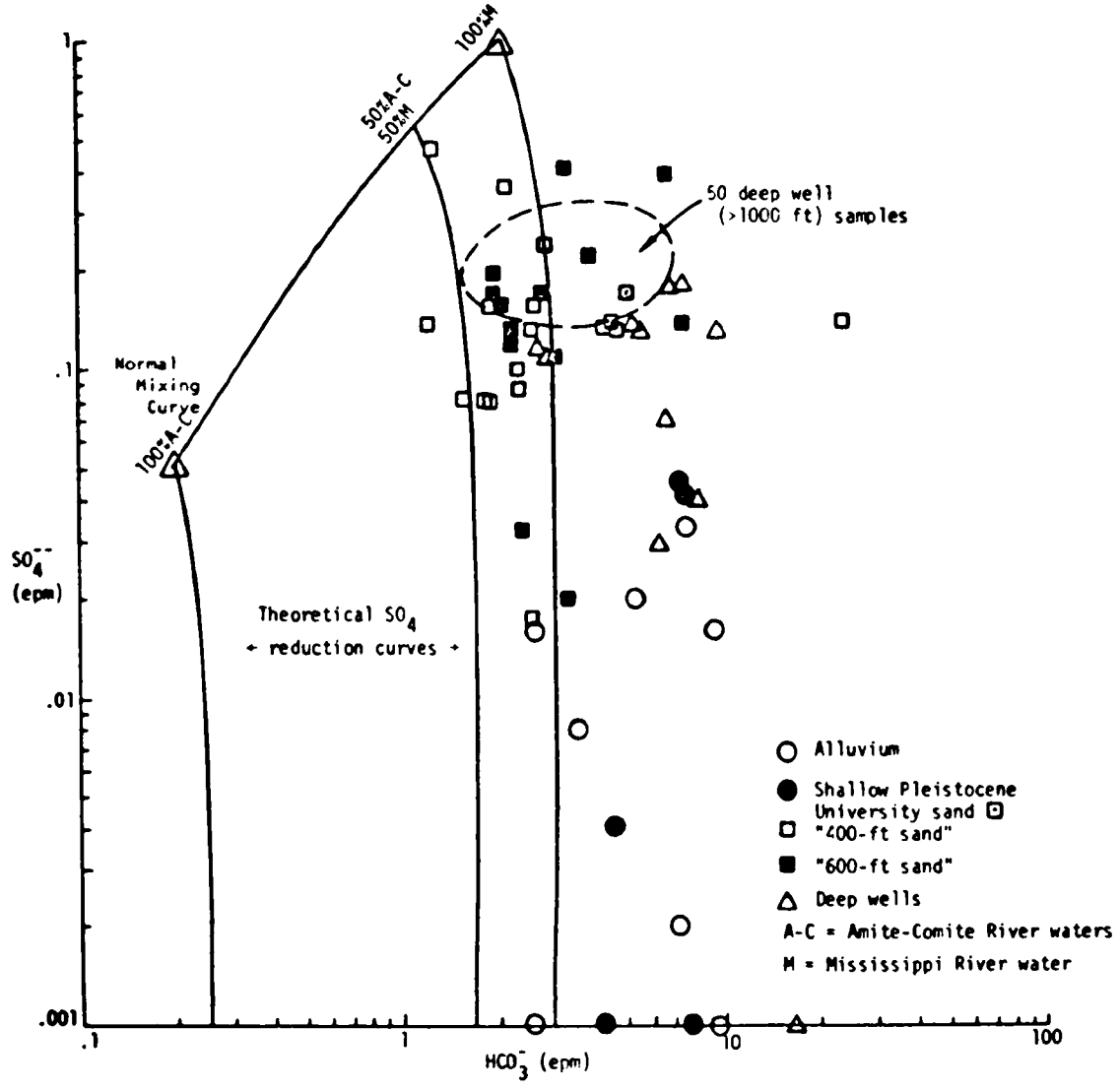


Figure 7.4 Sulfate-Bicarbonate Relation among the Ground Water Samples, Including a mixing curve of Mississippi River and Amite-Comite River waters, and sulfate reduction curves of the mixture.

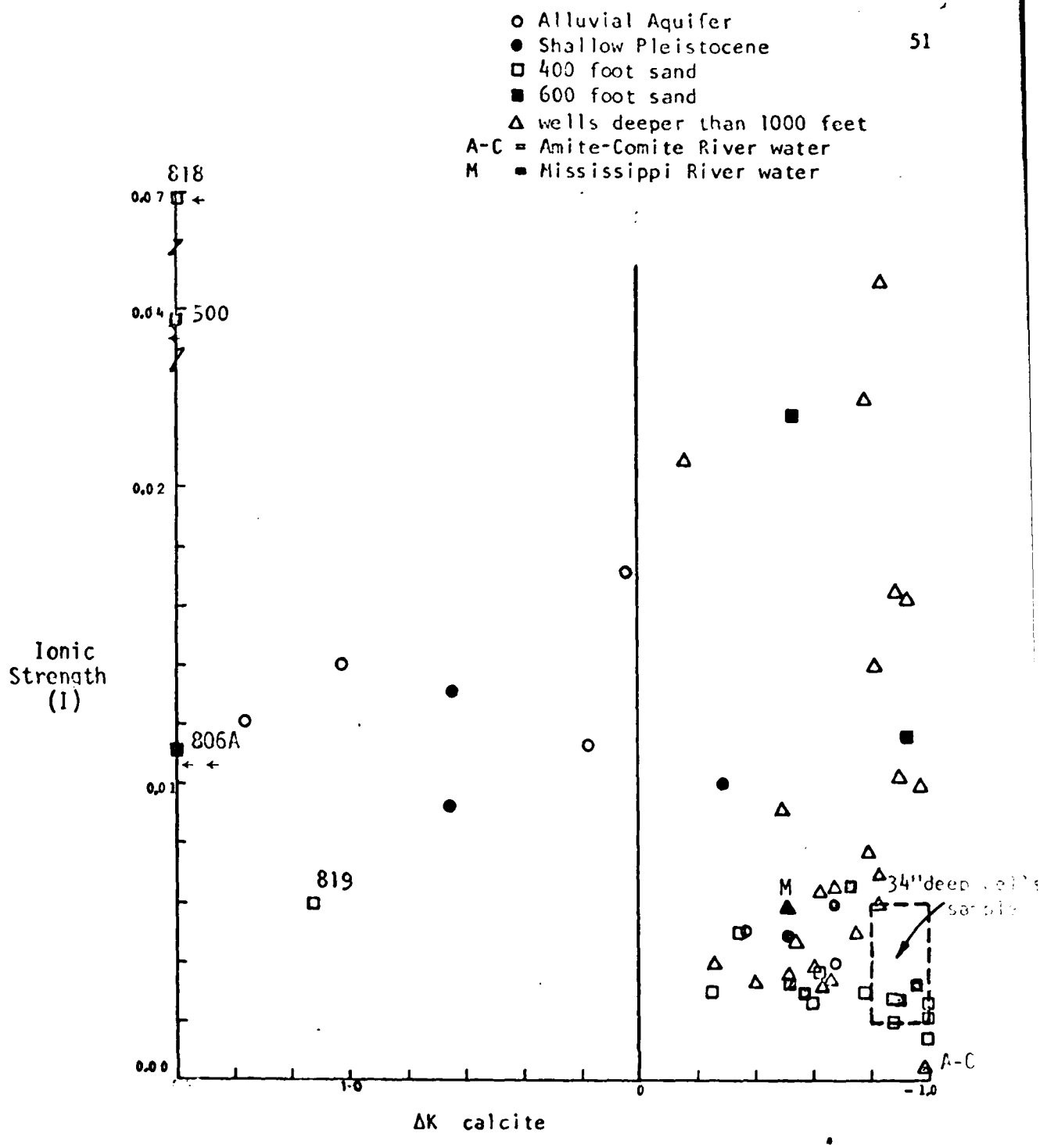


Figure 7.5 Relation between the Ionic Strength (I) and ΔK for the calcite in the ground water samples

to calcite. (Figure 7·5) There is no relationship between ionic strength and K except for those waters belonging to Type IIB. Only 3 samples were saturated with respect to dolomite, all others were undersaturated. The calculation of K based on ionic activity products suggests that carbonate solution ought to be taking place on a wide scale.

The absence of any association between the SO_4 and HCO_3 ionic abundances and lack of any dependence on depth (Figure 7·4) is further support for mineral solubility controlling the bicarbonate abundance. Sulfate reduction is apparently not an important mechanism.

SUMMARY

The principal mechanism in the origin of Type I (Chloride) waters in the Baton Rouge area is dilution of original chloride-rich estuarine or sea waters. Ion exchange and mineral solubility are of secondary importance.

The Type IIA waters (Na dominant bicarbonate) are the result of ion exchange and filtration as a result of clay compaction. Solution of carbonate minerals is less important. Type IIB (Ca and Mg dominant bicarbonate water) probably resulted from solution of carbonate minerals, and dilution by rainwater.

CHAPTER 8

CONCLUSION

The chemical character of the Baton Rouge ground water is related to the hydrological character of the aquifers, and the physico-chemical processes operative in them. The present water chemistry is the result of ion exchange, differential solubility of minerals, filtration due to compaction of clays and mixing of waters. The principal conclusions are as follows:

1. Ground water in Baton Rouge area are not chemically uniform. Based upon the principal anion, two major types have been detected; (i) Chloride waters, occur at various depths, but usually deeper than 500 feet, classified as Type I, and (ii) Bicarbonate waters, the most important by volume, classified as Type II. Depending upon the principal cation, Type II may be divided into two subtypes; (a) Na dominant, Type IIA, and (b) Ca and Mg dominant, Type IIB. In addition, there are certain ground waters which have an intermediate composition.

2. Hydrochemical facies of the ground water have been assigned by using the cations and anions, which constitute more than 5 percent of the principal ions and listing them in order of their decreasing abundance. Mapping the hydrochemical facies reveals that the water chemistry becomes less complex with depth. Ca and Mg are replaced by Na and the HCO_3 ion is the only significant anion. Chloride rich waters are confined to the vicinity of the Baton Rouge

fault and there is no systematic change in their composition with depth.

3. The Baton Rouge fault is the only structural feature in the area that influences the distribution of hydrochemical facies. Stratigraphic changes have no control on the water composition.

4. Distance from the industrial center and depth of occurrence have an effect on the dissolved solids in all aquifers. The Mississippi River is also important, but distance from the supposed recharge area (north of Baton Rouge) does not affect the water chemistry.

5. An assessment of the ionic interactions in the waters reveals a direct relationship between Ca and Mg as well as an inverse one between Na and Ca, and Na and Mg. The anions are not dependent on any of the cation variations. Bicarbonate distribution is not related to depth or other physical factors.

6. Compaction of clay materials associated with the sand units creates a semi-permeable membrane. The associated waters are enriched in Na and HCO_3 through the selective filtration action of these membranes. Extensive pumping accelerates the process. Ion exchange reactions coupled with this mechanism are chiefly responsible for the formation of Type IIA waters.

7. High Chloride waters (Type I) are thought to result from dilution of originally salty connate water.

8. The solution of calcite and dolomite and dilution are the principal agents in producing Type IIB waters.

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APPENDIX A

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm								pH	Specific Conductance (micromhos)
			K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^-	HCO_3	SiO_2		
					"Alluvial Aquifer"							
EB-586	3/19/57	372	5.2	19.0	117.0	39.0	15.0	0.8	593.0	33.0	7.1	879
EB-257	4/24/59	220	1.7	27.0	40.0	12.0	15.0	0.4	225.0	25.0	7.4	389
EB-232	5/3/55	175	3.2	16.0	84.0	28.0	3.8	0.1	458.0	40.0	7.1	670
EB-68	10/16/58	150	4.1	23.0	129.0	12.0	10.0	1.6	485.0	30.0	7.2	739
WBR-31	6/12/58	416	1.9	6.9	34.0	9.2	5.8	0.0	161.0	32.0	7.3	272
WBR-51	6/12/58	550	2.6	125.0	103.0	32.0	126.0	0.0	592.0	38.0	6.9	1210
EB-501	12/12/68	190	2.2	65.0	9.0	1.5	14.8	7.8	160.0	30.0	7.7	-
EB-100	5/9/51	338	2.4	20.0	62.0	18.0	7.2	1.0	314.0	34.0	7.5	505
					"Shallow Pleistocene Aquifer"							
EB-583	4/27/56	304	1.7	68.0	26.0	9.3	10.0	0.2	292.0	40.0	7.2	477
EB-665	11/25/58	116	1.3	52.0	76.0	42.0	72.0	2.2	462.0	31.0	7.3	879
EB-599	1/19/59	372	1.5	96.0	8.1	1.9	12.0	0.0	265.0	-	7.9	433
EB-631A	4/5/57	325	3.0	163.0	23.0	8.9	21.0	20.0	497.0	19.0	7.4	841
EB-681	2/24/59	289	2.2	153.0	26.0	7.1	14.0	0.0	500.0	18.0	7.7	759

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm								pH	Specific Conductance (micromhos)
			K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-	SiO_2		
					"University Sand Aquifer"							
EB-819	5/18/68	322	0.8	73.0	15.0	7.1	10.0	14.5	250.0	38.4	8.3	405
EB-511	4/15/68	336	2.0	71.0	14.0	7.2	4.0	7.2	260.6	40.0	7.8	474
EB-820	5/18/68	259	0.9	76.0	32.0	8.8	6.2	8.2	310.0	37.0	8.0	-
					"400 Foot Sand Aquifer"							
EB-823	8/16/67	583	0.6	120.0	4.0	1.7	81.0	0.4	204.0	27.0	8.0	559
EB-826	9/4/67	350	0.9	25.0	11.5	3.4	9.2	23.0	77.5	51.7	7.6	220
EB-822	8/23/67	573	7.5	60.0	26.0	9.3	5.0	7.0	286.0	34.0	9.5	345
EB-825	8/30/67	476	0.6	55.0	2.2	1.3	3.7	18.2	136.8	40.5	8.1	261
EB-818	9/12/67	616	6.8	1450.0	123.0	48.0	1750.0	7.0	1481.4	39.0	7.7	7363
EB-499	12/12/68	430	2.0	47.0	4.0	1.2	8.3	4.2	120.0	72.0	7.2	-
EB-34	12/12/68	410	2.3	46.0	3.9	1.2	6.9	4.0	120.0	80.0	7.6	-
EB-506	12/12/68	439	3.2	36.0	5.6	1.4	9.1	4.0	100.0	80.0	6.9	-
EB-827	5/16/68	370	2.4	18.0	7.4	4.2	6.6	7.0	77.4	47.3	7.8	-
EB-421	2/20/46	392	5.3	28.0	14.0	2.7	11.0	4.0	116.0	48.0	7.9	-
EB-354	1/25/45	416	4.0	45.0	7.6	2.8	6.8	4.9	146.0	50.0	7.8	252
EB-357	6/21/44	430	5.5	47.0	6.5	3.0	8.0	4.5	147.0	46.0	8.4	256
EB-155	1/25/45	412	4.5	30.0	13.0	3.3	8.0	7.9	119.0	48.0	7.5	229

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm								pH	Specific Conductance (micromhos)
			K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-	SiO_2		
EB-360	1/26/45	442	5.2	31.0	21.0	5.8	10.0	6.3	158.0	49.0	7.6	291
EB-703	1/14/60	-	0.5	140.0	3.8	0.1	116.0	4.8	177.0	26.0	-	662
EB-719	8/19/60	55	0.9	16.0	3.2	1.0	25.0	0.8	16.0	10.0	6.0	114
					"600 Foot Sand Aquifer"							
EB-824	8/30/67	582	0.3	82.0	2.5	0.8	3.7	20.0	209.7	38.4	7.0	264
EB-793	5/15/68	687	0.2	72.0	0.3	0.1	2.2	11.6	178.4	32.0	8.2	307
EB-806A	5/17/68	663	1.0	75.0	60.0	26.0	50.0	19.0	412.9	23.2	8.1	813
EB-500	5/15/68	741	10.5	660.0	95.5	27.0	1000.0	7.0	483.5	34.0	7.7	3488
EB-493	5/18/59	704	3.4	278.0	101.0	23.0	587.0	1.6	149.0	35.0	7.2	2110
EB-547	1/10/55	611	1.9	36.0	12.0	2.2	7.5	7.7	127.0	52.0	7.4	234
EB-60	1/26/45	644	4.4	30.0	14.0	3.3	6.0	8.3	124.0	54.0	7.9	233
EB-638	4/1/58	625	0.7	148.0	3.1	0.5	113.0	1.0	205.0	35.0	8.2	693
EB-518	5/6/52	550	0.8	36.0	11.0	2.7	7.2	9.4	122.0	55.0	7.4	234
EB-789A	6/25/65	711	1.4	237.0	9.8	4.7	284.0	5.6	187.0	24.0	7.2	1250
WBR-42	4/19/57	550	0.9	69.0	3.5	0.0	3.8	8.6	178.0	39.0	7.5	310
EB-473	12/12/68	692	1.9	58.0	2.2	0.5	3.8	6.2	140.0	42.0	7.8	-
EB-490	12/12/68	692	3.2	58.0	3.2	0.6	4.2	8.0	140.0	50.0	7.7	-

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-	SiO_2	pH	Specific Conductance (micromhos)
					"800 Foot Sand Aquifer"							
EB-159	3/24/59	790	0.9	75.0	0.9	0.1	4.9	11.0	159.0	29.0	9.0	312
EB-120	1/23/45	945	2.6	73.0	2.2	0.1	3.0	10.0	160.0	23.0	8.4	318
					"1000 Foot Sand Aquifer"							
WBR-104	5/16/68	1010	3.9	74.0	4.8	17.0	80.0	10.5	156.3	30.4	7.9	858
					"1200 Foot Sand Aquifer"							
EB-782A	5/14/68	1191	0.4	320.0	1.5	0.25	300.0	7.0	336.9	30.1	8.2	1589
EB-780A	4/19/65	1623	1.2	334.0	20.0	3.4	460.0	5.6	165.0	18.0	7.1	1770
EB-805	3/5/66	1072	1.4	500.0	15.0	3.1	680.0	5.4	178.0	20.0	7.6	2480
EB-756	8/9/68	1168	0.3	66.0	1.0	0.6	4.3	9.8	160.0	31.0	7.8	269
WBR-5	12/9/52	1338	0.5	70.0	0.2	0.0	3.3	9.9	166.0	30.0	8.1	279
EB-363	1949	1226	3.3	65.0	1.4	0.4	4.0	9.4	149.0	38.0	-	-
EB-653	11/25/58	1153	0.3	64.0	1.2	0.5	5.3	10.0	154.0	29.0	8.2	271
EB-403	3/23/53	1270	0.6	67.0	0.2	0.3	4.5	9.2	162.0	32.0	8.2	284
EB-219	4/30/59	1444	0.8	94.0	0.9	0.2	35.0	11.0	174.0	24.0	8.9	406
EB-35	3/13/59	1290	0.8	74.0	0.0	0.0	4.3	11.0	174.0	29.0	8.2	298
EB-37	3/6/59	1356	0.9	94.0	0.0	0.0	4.2	12.0	214.0	20.0	8.8	377

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-	SiO_2	pH	Specific Conductance (micromhos)
					"1500 Foot Sand Aquifer"							
EB-782B	5/14/68	1680	0.3	220.0	1.5	0.4	230.0	10.2	185.1	40.0	7.6	1216
WBR-100A	5/16/68	1884	0.5	67.0	0.2	0.03	2.2	10.5	166.4	33.0	7.9	311
EB-803A	5/15/68	1975	1.0	420.0	1.6	0.7	300.0	6.7	611.7	26.6	7.7	1916
EB-771	8/9/68	1739	0.4	72.0	0.4	0.0	4.2	11.0	176.0	26.0	8.0	302
EB-792A	7/14/65	1827	0.8	78.0	0.4	0.2	3.2	12.0	184.0	26.0	7.7	326
EB-777	3/11/65	1795	0.5	75.0	0.6	0.6	3.2	9.2	171.0	35.0	8.5	319
EB-780B	4/20/65	1916	1.2	607.0	17.0	3.1	7.4	1.4	382.0	23.0	7.1	2960
EB-632	11/25/58	1550	0.2	74.0	1.7	0.06	4.8	10.0	183.0	24.0	8.2	317
EB-413	6/6/52	1473	1.2	77.0	0.4	0.5	3.5	9.5	178.0	31.0	8.6	326
EB-157	5/8/59	1552	0.7	96.0	0.0	0.0	4.1	12.0	207.0	23.0	8.8	390
EB-510	5/9/51	1605	0.7	67.0	0.4	0.3	4.0	9.6	162.0	36.0	8.3	279
EB-807A	5/6/66	1713	0.3	88.0	0.4	0.0	2.6	10.0	208.0	31.0	7.6	356
					"1700 Foot Sand Aquifer"							
EB-68	6/20/44	1817	3.4	67.0	0.8	0.3	5.0	8.6	148.0	30.0	8.4	287
WBR-4	12/9/52	1863	0.6	70.0	0.1	0.1	3.2	9.1	173.0	26.0	8.1	280

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm								pH	Specific Conductance (micromhos)
			K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-	SiO_2		
					"2000 Foot Sand Aquifer"							
EB-806B	5/14/68	2565	1.0	363.0	3.0	1.0	350.0	8.8	371.9	27.8	7.4	1943
WBR-100B	5/16/68	2448	0.3	76.0	0.42	0.02	2.2	13.0	203.0	27.8	8.0	363.3
WBR-106	5/16/68	2012	0.6	105.0	0.5	0.02	2.2	10.0	270.7	28.3	8.0	417.6
EB-778	5/14/68	2589	0.6	230.0	0.4	0.03	80.0	9.0	472.6	26.0	8.3	908
EB-792B	7/15/65	2282	1.0	93.0	0.6	0.4	3.2	10.0	231.0	21.0	7.8	393
EB-367	1/10/55	2061	0.3	77.0	1.3	0.1	3.0	7.8	193.0	24.0	8.0	323
WBR-32	12/30/54	2096	0.4	85.0	0.8	0.1	3.0	10.0	205.0	24.0	7.5	350
EB-754	11/8/67	2374	0.4	84.0	1.2	0.2	3.1	8.8	205.0	22.0	7.9	347
EB-774	8/9/68	2145	0.3	69.0	0.8	0.0	3.0	10.0	170.0	22.0	7.8	292
EB-781	4/22/65	2286	2.3	699.0	28.0	1.2	1000.0	11.0	232.0	22.0	7.7	3600
EB-770	11/8/67	2082	0.3	108.0	0.4	0.0	3.1	9.6	279.0	20.0	8.2	456
EB-444	5/9/51	2249	2.0	91.0	1.0	0.3	5.0	11.0	209.0	24.0	7.5	350
EB-817	5/13/69	2284	1.2	90.0	1.6	0.2	2.5	12.0	235.0	19.0	7.9	385
EB-456	5/9/51	1895	3.2	83.0	1.3	0.2	3.8	9.0	186.0	23.0	8.8	347
EB-384	11/28/44	1919	3.7	71.0	3.7	0.1	4.0	7.9	189.0	26.0	8.2	383
EB-70	1944	2075	3.8	66.0	1.7	0.2	3.0	10.0	119.0	27.0	-	-
EB-804A	3/4/66	1950	0.3	88.0	0.0	0.0	1.4	12.0	214.0	24.0	7.8	367

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm								pH	Specific Conductance (micromhos)
			K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-	SiO_2		
EB-807B	5/6/66	2264	0.4	94.0	1.2	0.0	2.8	11.0	230.0	21.0	7.8	386
EB-783A	6/22/66	2179	1.6	171.0	1.9	0.5	118.0	7.2	248.0	26.0	8.1	807
					"2400 Foot Sand Aquifer"							
EB-468	3/15/48	2430	0.4	86.0	0.7	0.5	2.0	12.0	214.0	23.0	9.2	273
EB-352	6/22/44	2413	5.0	76.0	1.2	0.3	4.0	8.1	195.0	22.0	8.7	325
EB-551	1/5/55	2300	0.4	115.0	0.6	0.2	3.5	9.0	282.0	24.0	8.7	452
EB-794	5/15/68	2709	0.5	91.0	0.22	0.04	6.2	13.0	220.5	28.3	8.1	437
EB-806B	5/17/68	2579	0.8	77.0	9.0	4.4	15.0	11.0	220.3	28.3	7.9	437
EB-783B	6/22/65	2675	1.4	5.0	2.0	0.0	158.0	0.0	1010.0	19.0	8.3	2050
EB-804B	3/3/66	2765	0.3	109.0	2.3	0.1	1.2	12.0	266.0	23.0	7.8	447
EB-718	8/9/68	2380	0.6	72.0	1.8	0.4	4.5	8.6	179.0	22.0	7.8	292
EB-568	1/4/55	2449	0.4	90.0	0.8	0.1	3.2	9.4	219.0	22.0	7.6	284
EB-294	1/10/55	2278	0.4	84.0	0.2	0.1	4.9	8.9	190.0	19.0	8.9	337
EB-572	4/10/58	2511	0.4	121.0	1.1	0.0	4.8	8.6	278.0	25.0	9.1	483
					"2800 Foot Sand Aquifer"							
EB-798	8/18/65	2649	0.7	151.0	1.1	0.3	32.0	6.4	326.0	20.0	8.5	659
EB-578B	2/4/60	2800	0.8	74.0	1.3	0.2	4.0	8.6	183.0	22.0	8.9	307

TABLE A-1

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	Date of Sample	Total Depth (ft)	ppm								pH	Specific Conductance (micromhos)
			K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^-	HCO_3	SiO_2		
EB-378	2/4/60	2777	0.9	218.0	1.2	0.2	23.0	2.3	508.0	28.0	8.5	867
EB-517	8/28/52	2590	0.8	152.0	0.8	0.3	24.0	6.7	335.0	25.0	8.6	626
EB-534	1/10/55	2808	0.8	177.0	1.2	0.2	33.0	3.6	417.0	26.0	8.2	723

APPENDIX A-2

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
				"Alluvial Aquifer"			
EB-586	0.132	0.824	5.838	3.205	0.423	0.016	9.488
EB-257	0.043	0.171	1.996	0.986	0.423	0.008	3.600
EB-232	0.081	0.694	4.191	2.301	0.107	0.002	7.328
EB-68	0.104	0.998	6.437	0.986	0.282	0.033	7.760
WBR-31	0.048	0.299	1.696	0.756	0.163	0.000	2.576
WBR-51	0.066	5.425	5.139	2.630	3.553	0.000	9.472
EB-501	0.057	2.821	0.449	0.123	0.417	0.162	2.560
EB-100	0.061	0.870	3.093	1.480	0.203	0.020	5.146
				"Shallow Pleistocene Aquifer"			
EB-583	0.043	2.951	1.297	0.764	0.282	0.004	4.672
EB-665	0.033	2.256	3.792	3.452	2.030	0.045	7.392
EB-599	0.038	4.166	0.404	0.156	0.338	0.000	4.240
EB-631A	0.076	7.074	1.147	0.731	0.592	0.416	7.952
EB-681	0.056	6.640	1.297	0.583	0.394	0.000	8.000

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
			"University Sand Aquifer"				
EB-819	0.020	3.168	0.748	0.583	0.282	0.301	4.001
EB-511	0.052	3.081	0.698	0.591	0.113	0.149	4.170
EB-820	0.230	3.306	1.596	0.723	0.174	0.170	5.080
			"400 Foot Sand Aquifer"				
EB-823	0.015	5.220	0.199	0.139	2.284	0.008	3.343
EB-826	0.022	1.085	0.573	0.279	0.259	0.478	1.241
EB-822	0.191	2.604	1.297	0.764	0.141	0.145	4.576
EB-825	0.017	2.387	0.109	0.106	0.104	0.378	2.189
EB-818	0.174	62.930	6.137	3.945	49.350	0.145	23.702
EB-499	0.052	2.039	0.199	0.098	0.234	0.087	1.920
EB-34	0.061	1.996	0.194	0.098	0.194	0.083	1.920
EB-506	0.081	1.562	0.279	0.115	0.256	0.083	1.600
EB-827	0.063	0.781	0.369	0.345	0.186	0.145	1.239
EB-421	0.135	1.215	0.698	0.221	0.310	0.083	1.856
EB-354	0.102	1.953	0.379	0.230	0.191	0.101	2.336
EB-357	0.140	2.039	0.324	0.246	0.225	0.093	2.352

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
EB-155	0.114	1.302	0.648	0.271	0.225	0.164	1.904
EB-360	0.132	1.345	1.047	0.476	0.282	0.131	2,528
EB-703	0.012	6.090	0.189	0.008	3.272	0.099	2.901
EB-719	0.022	0.710	0.160	0.080	0.705	0.017	0.262
			"600 Foot Sand Aquifer"				
EB-824	0.007	3.558	0.124	0.069	0.104	0.416	3.356
EB-793	0.005	3.124	0.017	0.009	0.062	0.241	2.85
EB-806A	0.025	3.255	2.994	2.137	1.410	0.395	6.607
EB-500	0.267	28.640	4.760	2.219	28.200	0.145	7.736
EB-493	0.086	12.065	5.039	1.890	16.553	0.033	2.384
EB-547	0.048	1.562	0.598	0.180	0.211	0.160	2.032
EB-60	0.112	1.302	0.698	0.271	0.169	0.172	1.984
EB-638	0.020	6.430	0.150	0.040	3.190	0.020	3.360
EB-518	0.020	1.562	0.548	0.221	0.203	0.195	1.952
EB-789A	0.035	10.300	0.489	0.390	8.021	0.117	3.065
WBR-42	0.022	2.994	0.174	0.000	0.108	0.178	2.848
EB-473	0.048	2.517	0.109	0.042	0.108	0.128	2.240
EB-490	0.082	2.517	0.159	0.053	0.118	0.166	2.240

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
			"800 Foot Sand Aquifer"				
EB-159	0.022	3.240	0.045	0.005	0.138	0.229	2.962
EB-120	0.066	3.168	0.109	0.008	0.084	0.208	2.56
			"1000 Foot Sand Aquifer"				
WBR-104	0.101	3.211	0.239	1.397	2.256	0.218	2.502
			"1200 Foot Sand Aquifer"				
EB-782A	0.010	13.888	0.074	0.020	8.460	0.145	5.391
EB-780A	0.031	14.500	0.998	0.291	12.977	0.117	2.704
EB-805	0.036	21.740	0.748	0.251	19.183	0.112	2.917
EB-756	0.008	2.870	0.050	0.050	0.121	0.204	2.622
WBR-5	0.012	3.045	0.009	0.000	0.093	0.206	2.720
EB-363	0.084	2.827	0.069	0.032	0.112	0.195	2.442
EB-653	0.007	2.77	0.059	0.041	0.149	0.208	2.460
EB-403	0.015	2.90	0.009	0.024	0.126	0.191	2.590
EB-219	0.020	4.07	0.044	0.016	0.987	0.228	2.780
EB-35	0.020	3.21	0.000	0.000	0.121	0.228	2.780
EB-37	0.022	4.07	0.000	0.000	0.118	0.249	3.420

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
			"1500 Foot Sand Aquifer"				
EB-782B	0.008	9.548	0.072	0.032	6.486	0.212	2.963
WBR-100A	0.135	2.900	0.010	0.002	0.062	0.2184	2.663
EB-803A	0.025	18.220	0.077	0.057	8.460	0.139	9.788
EB-771	0.01	3.131	0.020	0.000	0.118	0.229	2.885
EB-792A	0.020	3.400	0.020	0.020	0.090	0.250	3.016
EB-777	0.013	3.280	0.030	0.050	0.090	0.192	2.803
EB-780B	0.031	26.400	0.848	0.251	21.045	0.029	6.261
EB-632	0.005	3.219	0.084	0.005	0.135	0.208	2.999
EB-413	0.030	3.341	0.019	0.041	0.098	0.197	2.848
EB-157	0.017	4.160	0.000	0.000	0.115	0.249	3.310
EB-510	0.017	2.900	0.019	0.024	0.112	0.199	2.590
EB-807A	0.008	3.826	0.020	0.000	0.073	0.208	3.409
			"1700 Foot Sand Aquifer"				
EB-68	0.086	2.900	0.039	0.024	0.141	0.178	2.360
WBR-4	0.015	3.030	0.004	0.008	0.090	0.189	2.760

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
			"2000 Foot Sand Aquifer"				
EB-803B	0.025	15.75	0.149	0.082	9.87	0.183	5.951
WBR-100B	0.009	3.298	0.026	0.002	0.062	0.270	3.248
WBR-106	0.015	4.557	0.024	0.002	0.062	0.208	4.332
EB-778	0.015	9.982	0.019	0.003	2.256	0.187	7.561
EB-792B	0.025	4.050	0.030	0.030	0.090	0.208	3.786
EB-367	0.007	3.34	0.064	0.008	0.084	0.162	3.080
WBR-32	0.010	3.680	0.039	0.008	0.084	0.208	3.280
EB-754	0.010	3.652	0.060	0.020	0.087	0.183	3.360
EB-774	0.008	3.000	0.040	0.000	0.085	0.208	2.786
EB-781	0.060	30.400	1.896	0.102	28.210	0.229	3.802
EB-770	0.008	4.696	0.020	0.000	0.087	0.200	4.573
EB-444	0.051	3.940	0.049	0.024	0.141	0.228	3.340
EB-817	0.031	3.913	0.080	0.020	0.071	0.250	3.852
EB-456	0.081	3.610	0.064	0.016	0.107	0.187	3.048
EB-384	0.094	3.088	0.184	0.008	0.112	0.164	3.097
EB-70	0.097	2.871	0.084	0.016	0.084	0.208	1.950
EB-804A	0.008	3.826	0.000	0.000	0.039	0.250	3.507

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
EB-807B	0.010	4.087	0.060	0.000	0.079	0.229	3.770
EB783A	0.040	7.440	0.095	0.045	3.329	0.150	4.065
			"2400 Foot Sand Aquifer"				
EB-468	0.010	3.741	0.034	0.041	0.056	0.249	3.507
EB-352	0.127	3.306	0.059	0.024	0.112	0.168	3.196
EB-551	0.010	5.002	0.029	0.016	0.098	0.187	4.621
EB-794	0.012	3.949	0.010	0.003	0.174	0.270	3.528
EB-806B	0.022	3.341	0.449	0.361	0.423	0.228	3.525
EB-783B	0.035	21.800	0.100	0.000	4.457	0.000	16.544
EB-804B	0.008	4.739	0.115	0.005	0.034	0.250	4.360
EB-718	0.015	3.131	0.090	0.030	0.127	0.179	2.934
EB-568	0.010	3.900	0.039	0.008	0.09	0.195	3.500
EB-294	0.010	3.640	0.009	0.008	0.138	0.185	3.040
EB-572	0.010	5.250	0.054	0.000	0.135	0.178	4.440
			"2800 Foot Sand Aquifer"				
EB-798	0.019	6.560	0.055	0.025	0.903	0.133	5.343
EB-578B	0.020	3.219	0.064	0.016	0.112	0.179	2.999

TABLE A-2

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	epm						
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-
EB-378	0.022	9.460	0.059	0.016	0.648	0.047	8.120
EB-517	0.020	6.590	0.039	0.024	0.676	0.139	5.360
EB-534	0.020	7.680	0.059	0.016	0.930	0.074	6.670

APPENDIX A-3

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
				"Alluvial Aquifer"				
EB-586	0.66	4.13	29.29	16.08	2.12	0.08	47.60	Ca>Mg:HCO_3
EB-257	0.52	14.24	24.25	11.98	5.14	0.10	43.74	Ca>Na>Mg:HCO_3>Cl
EB-232	0.55	4.72	28.50	15.65	0.72	0.01	49.82	Ca>Mg:HCO_3
EB-68	0.66	6.01	38.77	5.94	1.69	0.19	46.74	Ca>Na>Mg:HCO_3
WBR-31	0.87	5.40	30.62	13.64	2.95	0.00	46.49	Ca>Mg>Na:HCO_3
WBR-51	0.25	20.63	19.55	10.00	13.51	0.00	36.03	Na>Ca>Mg:HCO_3>Cl
EB-501	0.87	42.80	6.81	1.87	6.33	2.46	38.84	Na>Ca:HCO_3>Cl
EB-100	0.56	8.00	28.44	13.61	1.86	0.18	47.32	Ca>Mg>Na:HCO_3
				"Shallow Pleistocene Aquifer"				
EB-583	0.43	29.46	12.95	7.63	2.81	0.04	46.65	Na>Ca>Mg:HCO_3
EB-665	0.17	11.87	19.95	18.16	10.68	0.24	38.89	Ca>Mg>Na:HCO_3>Cl
EB-599	0.40	44.59	4.32	1.67	3.62	0.00	45.38	Na:HCO_3
EB-631A	0.42	39.32	6.37	4.06	3.29	2.31	44.20	Na>Ca:HCO_3
EB-681	0.33	39.12	7.64	3.43	2.32	0.00	47.13	Na>Ca:HCO_3

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
				"University Sand Aquifer"				
EB-819	0.22	39.79	8.22	6.40	3.09	3.47	43.94	$Na>Ca>Mg:HCO_3$
EB-511	0.59	34.78	7.88	6.68	1.27	1.69	47.07	$Na>Ca>Mg:HCO_3$
EB-820	2.03	29.31	14.15	6.41	1.54	1.50	45.03	$Na>Ca>Mg:HCO_3$
				"400 Foot Sand Aquifer"				
EB-823	0.13	46.56	1.78	1.24	20.37	0.07	29.82	$Na:HCO_3>Cl$
EB-826	0.58	27.53	14.56	7.09	6.58	12.14	31.50	$Na>Ca>Mg:HCO_3>SO_4>Cl$
EB-822	1.96	26.78	13.34	7.86	1.45	1.49	47.08	$Na>Ca>Mg:HCO_3$
EB-825	0.3	45.09	2.07	2.01	1.97	7.15	41.36	$Na:HCO_3>SO_4$
EB-818[b]	0.11	42.98	4.19	2.69	33.71	0.09	16.19	$Na:Cl>HCO_3$
EB-499	1.13	44.03	4.30	2.12	5.05	1.88	41.45	$Na:HCO_3>Cl$
EB-34	1.33	43.89	4.27	2.16	4.27	1.82	42.21	$Na:HCO_3$
EB-506	2.05	39.27	7.02	2.89	6.45	2.09	40.21	$Na>Ca:HCO_3>Cl$
EB-827	2.00	24.96	11.79	11.02	5.94	4.65	39.61	$Na>Ca>Mg:HCO_3>Cl$
EB-421	2.98	26.88	15.45	4.90	6.86	1.84	41.06	$Na>Ca:HCO_3>Cl$
EB-354	1.92	36.89	7.16	4.34	3.62	1.92	44.12	$Na>Ca:HCO_3$
EB-357	2.58	37.62	5.98	4.54	4.16	1.72	43.37	$Na>Ca:HCO_3$

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
EB-155	2.47	28.11	14.00	5.85	4.87	3.54	41.11	$Na>Ca>Mg:HCO_3$
EB-360	2.23	22.63	17.63	8.02	4.74	2.20	42.53	$Na>Ca>Mg:HCO_3$
EB-703	0.09	48.44	1.50	0.06	26.02	0.78	23.07	$Na:Cl>HCO_3$
EB-719	1.12	36.29	8.17	4.08	36.04	0.86	13.39	$Na>Ca:Cl>HCO_3$
				"600 Foot Sand Aquifer"				
EB-824	0.09	46.60	1.63	0.90	1.36	5.44	43.94	$Na;HCO_3>SO_4$
EB-793	0.08	49.47	0.28	0.15	0.98	3.81	45.19	$Na:HCO_3$
EB-806A	0.15	19.34	17.79	12.70	8.38	2.34	39.27	$Na>Ca>Mg:HCO_3>Cl$
EB-500	0.37	39.79	6.62	3.08	39.17	0.20	10.74	$Na>Ca:Cl>HCO_3$
EB-493	0.22	31.70	13.24	4.96	43.50	0.08	6.26	$Na>Ca:Cl>HCO_3$
EB-547	1.00	32.59	12.49	3.77	4.41	3.33	42.38	$Na>Ca:HCO_3$
EB-60	2.38	27.64	14.83	5.75	3.59	3.66	42.12	$Na>Ca>Mg:HCO_3$
EB-638	0.15	48.67	1.13	0.30	24.14	0.15	25.43	$Na:HCO_3>Cl$
EB-518	0.43	33.21	11.66	4.71	4.31	4.15	41.49	$Na>Ca:HCO_3$
EB-789A	0.15	45.96	2.18	1.74	35.75	0.52	13.67	$Na:Cl>HCO_3$
WBR-42	0.36	47.33	2.76	0.00	1.69	2.82	45.02	$Na:HCO_3$
EB-473	0.93	48.45	2.11	0.82	2.08	2.48	43.11	$Na:HCO_3$
EB-490	1.55	47.15	2.98	1.00	2.21	3.11	41.96	$Na;HCO_3$

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
				"800 Foot Sand Aquifer"				
EB-159	0.36	48.77	0.67	0.07	2.07	3.44	44.58	$Na:HCO_3$
EB-120	1.06	51.07	1.75	0.12	1.35	3.35	14.27	$Na:HCO_3$
				"1000 Foot Sand Aquifer"				
WBR-104	1.02	32.35	2.41	14.07	22.72	2.20	25.20	$Na>Mg:HCO_3>CL$
				"1200 Foot Sand Aquifer"				
EB-782A	0.03	49.61	0.26	0.07	30.22	0.52	19.26	$Na:Cl>HCO_3$
EB-780A	0.09	45.85	3.15	0.92	41.04	0.37	8.55	$Na:Cl>HCO_3$
EB-805	0.08	48.32	1.66	0.55	42.64	0.24	6.48	$Na:Cl>HCO_3$
EB-756	0.13	48.43	0.84	0.84	2.04	3.44	44.25	$Na:HCO_3$
WBR-5	0.20	50.30	0.14	0.00	1.52	3.38	44.69	$Na:HCO_3$
EB-363	1.45	49.07	1.19	0.55	1.94	3.38	42.38	$Na:HCO_3$
EB-653	0.12	48.64	1.03	0.72	2.61	3.65	43.20	$Na:HCO_3$
EB-403	0.25	49.53	0.15	0.40	2.15	3.26	44.23	$Na:HCO_3$
EB-219	0.24	49.96	0.54	0.19	12.11	2.79	34.13	$Na:HCO_3>Cl$
EB-35	0.31	50.47	0.00	0.00	1.90	3.58	43.71	$Na:HCO_3$
EB-37	0.27	51.65	0.00	0.00	1.49	3.16	43.40	$Na:HCO_3$

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
				"1500 Foot Sand Aquifer"				
EB-782B	0.04	49.41	0.37	0.16	33.56	1.09	15.33	$Na:Cl>HCO_3$
WBR-100A	2.24	48.46	0.18	0.04	1.03	3.63	44.38	$Na:HCO_3$
EB-803A	0.06	49.56	0.21	0.15	23.0	0.37	26.61	$Na:HCO_3>Cl$
EB-771	0.15	48.97	0.31	0.00	1.84	3.58	45.12	$Na:HCO_3$
EB-792A	0.29	49.88	0.29	0.29	1.32	3.66	44.24	$Na:HCO_3$
EB-777	0.20	50.78	0.46	0.77	1.39	2.97	43.40	$Na:HCO_3$
EB-780B	0.05	48.11	1.54	0.45	38.35	0.05	11.41	$Na:Cl>HCO_3$
EB-632	0.07	48.35	1.27	0.07	2.03	3.12	45.05	$Na:HCO_3$
EB-413	0.46	50.80	0.30	0.62	1.50	3.00	43.29	$Na:HCO_3$
EB-157	0.21	52.98	0.00	0.00	1.46	3.17	42.16	$Na:HCO_3$
EB-510	0.29	49.47	0.32	0.40	1.91	3.39	44.19	$Na:HCO_3$
EB-807A	0.10	50.71	0.26	0.00	0.96	2.75	45.18	$Na:HCO_3$
				"1700 Foot Sand Aquifer"				
EB-68	1.50	50.62	0.68	0.41	2.46	3.10	41.20	$Na:HCO_3$
WBR-4	0.24	49.70	0.06	0.13	1.47	3.10	45.27	$Na:HCO_3$

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
				"2000 Foot Sand Aquifer"				
EB-803B	0.07	49.20	0.46	0.25	30.82	0.57	18.58	$Na:Cl>HCO_3$
WBR-100B	0.14	47.67	0.38	0.02	0.89	3.90	46.95	$Na:HCO_3$
WBR-106	0.17	49.52	0.27	0.01	0.67	2.26	47.08	$Na:HCO_3$
EB-778	0.07	49.84	0.09	0.01	11.26	0.93	37.76	$Na:HCO_3>Cl$
EB-792B	0.30	49.27	0.36	0.36	1.09	2.53	46.06	$Na:HCO_3$
EB-367	0.10	49.51	0.94	0.11	1.24	2.40	45.66	$Na:HCO_3$
WBR-32	0.13	50.34	0.53	0.10	1.14	2.84	45.87	$Na:HCO_3$
EB-754	0.13	49.53	0.81	0.27	1.18	2.48	45.57	$Na:HCO_3$
EB-774	0.13	48.96	0.65	0.00	1.38	3.39	45.47	$Na:HCO_3$
EB-781	0.09	46.98	2.93	0.15	43.60	0.35	5.87	$Na:Cl>HCO_3$
EB-770	0.08	48.99	0.20	0.00	0.90	2.08	47.71	$Na:HCO_3$
EB-444	0.65	50.68	0.63	0.30	1.81	2.93	42.96	$Na:HCO_3$
EB-817	0.37	47.62	0.97	0.24	0.86	3.04	46.87	$Na:HCO_3$
EB-456	1.13	50.75	0.89	0.22	1.50	2.62	42.85	$Na:HCO_3$
EB-384	1.39	45.76	2.72	0.11	1.65	2.43	45.90	$Na:HCO_3$
EB-70	1.82	54.06	1.58	0.30	1.58	3.91	36.72	$Na:HCO_3$
EB-804A	0.10	50.14	0.00	0.00	0.51	3.27	45.96	$Na:HCO_3$

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
EB-807B	0.12	49.62	0.72	0.00	0.95	2.78	45.78	$Na:HCO_3$
EB-783A	0.26	49.06	0.62	0.29	21.95	0.98	26.80	$Na:HCO_3>Cl$
				"2400 Foot Sand Aquifer"				
EB-468	0.13	48.97	0.44	0.53	0.73	3.26	45.91	$Na:HCO_3$
EB-352	1.81	47.28	0.84	0.34	1.60	2.40	45.70	$Na:HCO_3$
EB-551	0.10	50.20	0.29	0.16	0.98	1.87	46.38	$Na:HCO_3$
EB-794	0.16	49.67	0.13	0.04	2.19	3.40	44.38	$Na:HCO_3$
EB-806B	0.26	40.01	5.37	4.32	5.06	2.73	42.20	$Na>Ca:HCO_3>Cl$
EB-783B	0.08	50.77	0.23	0.00	10.38	0.00	38.53	$Na:HCO_3>Cl$
EB-804B	0.08	49.82	1.20	0.05	0.35	2.62	45.84	$Na:HCO_3$
EB-718	0.23	48.12	1.38	0.46	1.95	2.75	45.09	$Na:HCO_3$
EB-568	0.12	50.37	0.50	0.10	1.16	2.51	45.20	$Na:HCO_3$
EB-294	0.14	51.77	0.12	0.11	1.96	2.63	43.24	$Na:HCO_3$
EB572	0.09	52.15	0.53	0.00	1.34	1.76	44.10	$Na:HCO_3$
				"2800 Foot Sand Aquifer"				
EB-798	0.14	50.31	0.42	0.19	6.92	1.02	40.98	$Na:HCO_3>Cl$
EB-578B	0.30	48.70	0.96	0.24	1.69	2.70	45.37	$Na:HCO_3$

TABLE A-3

CHEMICAL ANALYSES OF THE GROUND WATER IN THE BATON ROUGE AREA, LOUISIANA

Well No.	percent epm							Hydrochemical Facies
	K^+	Na^+	Ca^{++}	Mg^{++}	Cl^-	$SO_4^{=}$	HCO_3^-	
EB-378	0.11	51.49	0.32	0.08	3.52	0.25	44.19	$Na:HCO_3$
EB-517	0.15	51.29	0.30	0.18	5.26	1.08	41.71	$Na:HCO_3>Cl$
EB-534	0.12	49.71	0.38	0.10	6.01	0.47	43.17	$Na:HCO_3>Cl$

APPENDIX B

TABLE B-1

ACTIVITIES* OF THE DISSOLVED CONSTITUENTS IN GROUND WATERS
OF BATON ROUGE, LOUISIANA

Well No.	Ionic Strength	K^+ 10^{-5}	Na^+ 10^{-5}	Ca^{++} 10^{-5}	Mg^{++} 10^{-5}	Cl^- 10^{-5}	SO_4^{--} 10^{-5}	HCO_3^- 10^{-5}	H_4SiO_4 10^{-5}	H^+ 10^{-10}	CO_3^{--}** 10^{-5}
					"Alluvial Aquifer"						
EB-568	0.014	11.74	73	186.27	105.10	37.36	0.51	861	54.92	794	0.54
EB-257	0.005	4.02	108	74.62	37.32	39.14	0.30	341	41.60	398	0.42
EB-232	0.010	7.33	62	140.35	78.78	9.60	0.06	674	66.57	794	0.42
EB-68	0.012	9.33	89	211.04	33.13	25.11	1.06	710	49.92	630	0.56
EB-31	0.004	4.53	28	65.18	29.35	15.25	0.00	246	53.25	501	0.24
EB-51	0.017	5.80	477	158.07	83.50	310.35	0.00	851	63.24	1258	0.33
EB-501	0.003	5.45	264	17.46	4.83	39.05	6.26	245	49.93	199	0.61
EB-100	0.007	5.56	79	108.96	53.00	18.46	0.72	469	56.58	316	0.74
					"Shallow Pleistocene Aquifer"						
EB-583	0.006	3.99	272	47.35	28.29	25.92	0.15	440	66.50	630	0.34
EB-665	0.013	2.95	201	122.59	114.52	180.07	1.44	673	51.50	501	0.67
EB-599	0.005	3.54	387	15.11	5.90	31.31	0.00	402	--	125	1.60
EB-631A	0.010	6.89	639	38.80	25.25	53.23	13.83	734	31.60	398	0.92
EB-681	0.009	5.08	602	44.61	20.46	35.66	0.00	741	29.90	199	1.86
					"University Sand Aquifer"						
EB-819	0.005	1.91	293	27.70	21.88	26.02	11.05	378	63.91	50	3.78
EB-511	0.005	4.89	285	25.98	22.29	10.42	5.51	395	66.57	158	1.25
EB-820	0.006	2.10	302	57.38	26.39	15.99	6.05	465	61.57	99	2.34

*Activity = molality x activity coefficient. **Calculated.

TABLE B-1

ACTIVITIES* OF THE DISSOLVED CONSTITUENTS IN GROUND WATERS
OF BATON ROUGE, LOUISIANA

Well No.	Ionic Strength	K^+ 10^{-5}	Na^+ 10^{-5}	Ca^{++} 10^{-5}	Mg^{++} 10^{-5}	Cl^- 10^{-5}	SO_4^{--} 10^{-5}	HCO_3^- 10^{-5}	H_4SiO_4 10^{-5}	H^+ 10^{-10}	CO_3^{--}** 10^{-5}
					"400-ft Sand Aquifer"						
EB-823	0.003	2.81	270	5.32	4.58	233.28	7.19	4	44.93	9	0.26
EB-826	0.003	2.17	102	23.09	11.32	24.51	19.15	120	86.04	251	0.23
EB-822	0.006	17.62	240	47.35	28.29	12.96	5.25	431	56.58	3	71.90
EB-825	0.003	1.63	225	4.36	4.28	9.82	14.98	211	64.90	79	1.33
EB-818	0.078	13.54	4960	131.68	92.65	3815.54	2.87	1908	64.90	199	4.79
EB-499	0.002	5.00	193	8.06	4.01	22.13	3.51	186	119.83	630	0.14
EB-34	0.002	5.76	189	7.89	4.02	18.42	1.67	186	133.14	251	0.37
EB-506	0.002	7.76	148	11.42	4.73	24.34	3.38	155	133.14	1258	0.06
EB-827	0.002	5.98	74	15.22	14.32	17.70	5.98	120	78.72	158	0.38
EB-421	0.003	12.78	115	28.01	8.96	29.27	3.31	179	79.88	125	0.71
EB-354	0.003	9.62	184	15.04	9.20	18.04	4.01	225	83.21	158	0.71
EB-357	0.003	13.23	192	12.86	9.85	21.22	3.69	226	76.55	39	2.90
EB-155	0.003	10.84	123	25.91	10.91	21.26	6.52	183	79.88	316	0.29
EB-360	0.004	12.42	126	40.50	18.60	26.34	5.02	242	81.55	251	0.48
EB-703	0.006	1.16	558	6.85	0.30	299.89	3.56	266	43.27	--	--
EB-719	0.001	2.21	66	6.89	3.56	67.90	0.71	25	16.64	9999	0.00
					"600-ft Sand Aquifer"						
EB-824	0.004	0.71	332	4.77	2.66	9.72	15.81	320	64.00	999	0.16
EB-793	0.003	0.52	294	0.70	0.39	5.82	9.41	274	53.20	63	2.17
EB-806A	0.011	2.28	292	99.32	72.55	126.03	12.87	606	38.60	79	3.83
EB-500	0.039	22.09	2386	121.96	60.20	2320.74	3.54	658	56.50	199	1.65
EB-493	0.022	7.45	1044	146.50	57.14	1420.43	0.93	210	58.25	630	0.16
EB-547	0.003	4.58	147	23.92	7.27	19.94	6.36	196	86.54	398	0.24
EB-60	0.003	10.59	123	27.80	10.88	15.93	6.83	191	89.87	125	0.76
EB-638	0.006	1.63	590	5.55	1.49	291.61	0.73	307	50.28	63	2.44

TABLE B-1

ACTIVITIES* OF THE DISSOLVED CONSTITUENTS IN GROUND WATERS
OF BATON ROUGE, LOUISIANA

Well No.	Ionic Strength	K^+ 10^{-5}	Na^+ 10^{-5}	Ca^{++} 10^{-5}	Mg^{++} 10^{-5}	Cl^- 10^{-5}	SO_4^{--} 10^{-5}	HCO_3^- 10^{-5}	H_4SiO_4 10^{-5}	H^+ 10^{-10}	CO_3^{--}** 10^{-5}
EB-518	0.003	1.92	147	21.92	8.93	19.14	7.76	188	91.53	398	0.23
EB-789A	0.011	3.19	922	16.12	13.04	714.57	3.76	274	39.94	630	0.21
WBR-42	0.003	2.15	281	6.85	0.00	10.05	6.97	273	64.90	--	--
EB-473	0.003	4.58	238	4.40	1.72	10.25	5.14	216	69.90	158	0.68
EB-490	0.003	7.83	238	6.37	2.15	11.16	6.61	216	83.21	199	0.54
					"800-ft Sand Aquifer"						
EB-159	0.003	2.16	306	1.76	0.32	12.97	8.95	244	48.26	9	13.60
EB-120	0.003	6.23	298	4.31	0.32	7.94	8.14	246	38.27	39	3.15
					"1000-ft Sand Aquifer"						
WBR-104	0.006	9.35	296	8.76	51.83	207.50	7.90	235	50.60	125	0.94
					"1200-ft Sand Aquifer"						
EB-782A	0.014	0.92	1233	2.38	0.67	746.97	4.53	489	50.20	63	3.88
EB-780A	0.016	2.68	1278	31.05	8.96	1137.00	3.53	238	29.90	794	0.14
EB-805	0.023	3.06	1874	21.65	7.67	1643.00	3.14	251	33.20	251	0.50
EB-756	0.003	0.71	270	1.96	1.95	11.39	8.01	246	51.50	158	0.77
WBR-5	0.003	1.19	286	0.38	0.00	8.74	8.09	256	49.90	79	1.62
EB-363	0.003	7.93	265	2.76	1.31	10.61	7.71	229	63.20	--	--
EB-653	0.003	0.71	261	2.37	1.63	14.05	8.20	237	48.20	63	1.88
EB-403	0.003	1.43	274	0.38	0.98	11.94	7.54	249	53.20	99	1.25
EB-219	0.004	1.89	380	1.71	0.63	91.93	8.67	265	39.90	12	11.04
EB-35	0.003	1.91	301	0.00	0.00	11.37	8.93	267	48.20	63	2.11
EB-37	0.004	2.14	380	0.00	0.00	11.03	9.49	327	33.20	15	10.90

TABLE B-1

ACTIVITIES* OF THE DISSOLVED CONSTITUENTS IN GROUND WATERS OF BATON ROUGE, LOUISIANA

Well No.	Ionic Strength	K^+ 10^{-5}	Na^+ 10^{-5}	Ca^{++} 10^{-5}	Mg^{++} 10^{-5}	Cl^- 10^{-5}	SO_4^{--} 10^{-5}	HCO_3^- 10^{-5}	H_4SiO_4 10^{-5}	H^+ 10^{-10}	CO_3^{--}** 10^{-5}
					"1500-ft Sand Aquifer"						
EB-782B	0.009	0.73	863	2.45	1.13	583.58	7.07	273	66.50	251	0.54
WBR-100A	0.003	1.27	273	0.43	0.09	5.82	8.55	256	54.90	125	1.02
EB-803A	0.018	2.22	1595	2.33	1.79	734.89	4.09	875	44.30	199	2.19
EB-771	0.003	0.95	294	0.77	0.00	11.11	8.93	279	43.20	99	1.36
EB-792A	0.003	1.91	317	0.77	0.64	8.44	9.68	282	43.20	199	0.70
EB-777	0.003	1.19	306	1.17	1.94	8.46	7.46	263	58.20	31	4.24
EB-780B	0.027	2.59	2253	23.71	7.44	1782.00	0.78	534	38.20	794	0.33
EB-157	0.004	1.66	389	0.00	0.00	10.77	9.49	316	38.20	15	10.53
EB-510	0.003	1.68	274	0.78	0.98	10.61	7.87	249	59.90	50	2.49
EB-807A	0.004	0.71	357	0.76	0.00	6.84	7.98	318	51.60	251	0.63
					"1700-ft Sand Aquifer"						
EB-68	0.003	8.17	274	1.57	0.98	13.26	7.05	228	49.90	39	2.92
WBR-4	0.003	1.43	286	0.18	0.32	8.47	7.44	266	43.20	79	1.68
					"2000-ft Sand Aquifer"						
EB-803B	0.016	2.23	1388	4.64	2.62	864.25	5.53	535	46.20	398	0.67
WBR-100B	0.003	0.93	309	0.81	0.06	5.80	10.44	311	46.20	99	1.57
WBR-106	0.005	1.47	424	0.93	0.05	5.75	7.76	411	47.10	99	2.08
EB-778	0.010	1.37	901	0.67	0.08	202.59	6.20	697	43.20	50	6.97
EB-792B	0.004	2.37	376	1.13	1.26	8.40	7.88	352	34.90	158	1.11
EB-367	0.003	0.71	313	2.52	0.32	7.92	6.28	296	39.90	99	1.49
WBR-32	0.004	0.95	345	1.53	0.31	7.90	7.98	314	39.90	316	0.49
EB-754	0.004	0.95	341	2.31	0.63	8.16	7.03	314	36.60	125	1.25
EB-774	0.003	0.71	282	1.57	0.00	7.95	8.21	262	36.60	158	0.82

TABLE B-1

ACTIVITIES* OF THE DISSOLVED CONSTITUENTS IN GROUND WATERS OF BATON ROUGE, LOUISIANA

Well No.	Ionic Strength	K^+ 10^{-5}	Na^+ 10^{-5}	Ca^{++} 10^{-5}	Mg^{++} 10^{-5}	Cl^- 10^{-5}	SO_4^{--} 10^{-5}	HCO_3^- 10^{-5}	H_4SiO_4 10^{-5}	H^+ 10^{-10}	CO_3^{--}** 10^{-5}
EB-781	0.032	4.92	2565	37.59	2.78	2359.00	5.90	320	36.60	199	0.80
EB-770	0.005	0.70	435	0.74	0.00	8.10	7.44	424	33.30	63	3.36
EB-444	0.005	4.76	368	1.90	0.95	13.14	8.70	319	39.90	316	0.50
EB-817	0.004	2.84	364	3.04	0.63	6.56	9.46	359	31.60	125	1.43
EB-456	0.003	7.65	338	2.52	0.64	10.02	7.23	285	38.30	15	9.50
EB-384	0.003	8.86	288	7.20	0.32	10.56	6.37	290	43.30	63	2.30
EB-70	0.003	9.15	270	3.38	0.65	7.97	8.26	184	44.90	--	--
EB-804A	0.004	0.70	357	0.00	0.00	3.67	9.55	327	39.90	158	1.03
EB-807B	0.004	0.94	380	2.28	0.00	7.34	8.67	315	34.90	158	0.99
EB-783A	0.007	3.72	677	3.38	1.46	302.70	5.20	370	43.30	79	2.34
					"2400-ft Sand Aquifer"						
EB-468	0.004	0.95	349	1.34	1.59	5.26	9.55	327	38.20	6	27.25
EB-352	0.003	11.88	309	2.32	0.96	10.55	6.51	299	36.60	19	7.86
EB-551	0.005	0.94	463	1.11	0.62	9.13	6.93	428	39.90	19	11.26
EB-794	0.004	1.42	420	1.50	0.00	10.73	8.57	390	36.60	79	2.46
EB-806B	0.004	2.08	311	16.92	13.78	39.23	8.54	335	47.10	125	1.34
EB-783B	0.021	3.08	1886	2.92	0.00	383.50	0.00	1433	31.60	50	14.33
EB-804B	0.005	0.70	439	4.29	0.31	3.13	9.27	404	38.30	158	1.27
EB-718	0.003	1.43	293	3.51	1.29	11.89	6.95	274	36.60	158	0.87
EB-568	0.004	0.95	364	1.52	0.31	8.40	7.43	334	36.60	241	0.66
EB-294	0.003	0.95	341	0.38	0.32	12.93	7.15	291	31.60	12	12.12
EB-572	0.005	0.94	486	2.03	0.00	12.50	6.59	421	41.60	7	30.07

TABLE B-1

ACTIVITIES* OF THE DISSOLVED CONSTITUENTS IN GROUND WATERS
OF BATON ROUGE, LOUISIANA

Well No.	Ionic Strength	K^+ 10^{-5}	Na^+ 10^{-5}	Ca^{++} 10^{-5}	Mg^{++} 10^{-5}	Cl^- 10^{-5}	SO_4^{--} 10^{-5}	HCO_3^- 10^{-5}	H_4SiO_4 10^{-5}	H^+ 10^{-10}	CO_3^{--}** 10^{-5}
					"2800-ft Sand Aquifer"						
EB-798	0.006	1.63	601	1.97	0.89	82.65	4.74	490	33.30	31	7.90
EB-578B	0.003	1.91	301	2.53	0.64	10.57	6.95	281	36.60	12	11.70
EB-378	0.009	2.07	857	2.04	0.57	58.51	1.60	753	46.60	31	12.14
EB-517	0.006	1.86	606	1.83	0.89	61.98	4.96	503	41.60	25	10.06
EB-534	0.007	1.85	700	2.10	0.58	84.63	2.59	622	43.30	63	4.93

TABLE B-2

SOLUBILITY VALUES IN THE GROUND WATER OF THE BATON ROUGE, LOUISIANA, AREA

Well No.	K'* $CaCO_3$ 10^{-10}	ΔK** $CaCO_3$	K'* $CaMg(CO_3)_2$ 10^{-20}	ΔK** $CaMg(CO_3)_2$	$\log[K^+]/[H^+]$	$\log[H_4SiO_4]$
			"Alluvial Aquifer"			
EB-586	100.58	+ 1.01	5708.64	+ 1.85	3.16	- 3.26
EB-257	31.34	- 0.37	491.24	- 0.75	3.00	- 3.38
EB-232	58.94	+ 0.18	1950.41	- 0.02	2.96	- 3.17
EB-68	118.18	+ 1.36	2192.61	+ 0.09	3.17	- 3.30
WBR-31	15.64	- 0.68	110.19	- 0.94	2.95	- 3.27
WBR-51	52.16	+ 0.04	1437.35	- 0.28	2.66	- 3.19
EB-501	10.65	- 0.78	31.37	- 0.98	3.43	- 3.30
EB-100	80.63	+ 0.61	3162.32	+ 0.58	3.24	- 3.24
			"Shallow Pleistocene Aquifer"			
EB-583	16.09	- 0.68	154.84	- 0.92	2.80	- 3.17
EB-665	82.13	+ 0.64	6302.11	+ 2.15	2.76	- 3.28
EB-599	24.17	- 0.52	228.22	- 0.88	3.45	- 5.70
EB-631A	35.69	- 0.29	829.21	- 0.58	3.23	- 3.50
EB-681	82.97	+ 0.66	3157.64	+ 0.57	3.40	- 3.52

*$K_{IAP} = [Ca][CO_3]$

$K_{IAP} = [Ca][Mg][CO_3]^2$

** $\Delta K = \frac{K_{IAP}}{K} - 1$

TABLE B-2

SOLUBILITY VALUES IN THE GROUND WATER OF THE BATON ROUGE, LOUISIANA, AREA

Well No.	K'* $CaCO_3$ 10^{-10}	ΔK** $CaCO_3$	K'* $CaMg(CO_3)_2$ 10^{-20}	ΔK** $CaMg(CO_3)_2$	$\log[K^+]/[H^+]$	$\log[H_4SiO_4]$
			"University Sand"			
EB-819	104.70	+ 1.09	8659.85	+ 3.32	3.58	- 3.19
EB-511	32.47	- 0.35	904.83	- 0.54	3.49	- 3.17
EB-820	134.26	+ 1.68	8291.47	+ 3.14	3.32	- 3.21
			"400-ft Sand Aquifer"			
EB-823	1.38	- 0.97	1.64	- 0.99	4.49	- 3.24
EB-826	5.31	- 0.90	13.82	- 0.99	2.93	- 3.06
EB-822	3404.46	+67.08	6,924,855.43	+3461.40	5.76	- 3.24
EB-825	5.79	- 0.88	33.00	- 0.98	3.31	- 3.17
EB-818	630.74	+11.61	279,921.51	+138.96	3.83	- 3.18
EB-499	1.12	- 0.97	0.63	- 0.99	2.89	- 2.92
EB-34	2.91	- 0.94	4.34	- 0.99	3.36	- 2.87
EB-506	0.68	- 0.98	0.19	- 0.99	2.78	- 2.87
EB-827	5.78	- 0.88	31.47	- 0.98	3.57	- 3.10
EB-421	19.88	- 0.60	126.51	- 0.93	4.00	- 3.09
EB-354	10.67	- 0.78	69.75	- 0.96	3.78	- 3.07
EB-357	37.29	- 0.25	1,065.30	- 0.46	4.53	- 3.11
EB-155	7.51	- 0.85	23.77	- 0.98	3.53	- 3.09
EB-360	19.44	- 0.61	173.56	- 0.91	3.69	- 3.08
EB-719	0.00	- 1.00	0.00	- 1.00	1.34	- 3.77
			"600-ft Sand Aquifer"			
EB-824	0.76	- 0.98	0.32	- 0.99	1.85	- 3.19
EB-793	1.52	- 0.97	1.29	- 0.99	2.92	- 3.27
EB-806A	380.39	+ 6.61	105,699.19	+51.84	3.46	- 3.41

TABLE B-2

SOLUBILITY VALUES IN THE GROUND WATER OF THE BATON ROUGE, LOUISIANA, AREA

Well No.	K'* $CaCO_3$ 10^{-10}	ΔK^{**} $CaCO_3$	K'* $CaMg(CO_3)_2$ 10^{-20}	ΔK^{**} $CaMg(CO_3)_2$	$\log[K^+]/[H^+]$	$\log[H_4SiO_4]$
EB-500	201.23	+ 3.02	19,990.23	+ 8.99	4.04	- 3.24
EB-493	23.44	- 0.53	214.29	- 0.89	3.07	- 3.23
EB-547	5.74	- 0.88	10.01	- 0.99	3.06	- 3.06
EB-60	21.12	- 0.57	174.70	- 0.91	3.92	- 3.04
EB-638	13.54	- 0.73	49.23	- 0.97	3.41	- 3.23
EB-518	5.04	- 0.90	10.35	- 0.99	2.68	- 3.03
EB-789A	3.38	- 0.93	9.27	- 0.99	2.70	- 3.39
EB-473	2.99	- 0.94	3.49	- 0.99	3.46	- 3.15
EB-490	3.43	- 0.93	3.99	- 0.99	3.59	- 3.07
			"800-ft Sand Aquifer"			
EB-159	23.92	- 0.52	104.16	- 0.94	4.38	- 3.31
EB-120	13.57	- 0.72	13.68	- 0.99	4.20	- 3.41
			"1000-ft Sand Aquifer"			
WBR-104	8.23	- 0.83	401.18	- 0.80	3.87	- 3.29
			"1200-ft Sand Aquifer"			
EB-782A	9.23	- 0.81	24.00	- 0.98	3.16	- 3.29
EB-780A	4.34	- 0.91	5.45	- 0.99	2.52	- 3.52
EB-805	10.82	- 0.78	41.51	- 0.97	3.08	- 3.47
EB-756	1.50	- 0.97	2.26	- 0.99	2.65	- 3.28
WBR-5	0.61	- 0.98	0.00	- 1.00	3.17	- 3.30
EB-653	4.45	- 0.91	13.65	- 0.99	3.05	- 3.31
EB-403	0.47	- 0.99	0.58	- 0.99	3.15	- 3.27
EB-219	18.87	- 0.62	131.30	- 0.93	4.19	- 3.39
EB-35	0.00	- 1.00	0.00	- 1.00	3.48	- 3.31
EB-37	0.00	- 1.00	0.00	- 1.00	4.15	- 3.47

TABLE B-2

SOLUBILITY VALUES IN THE GROUND WATER OF THE BATON ROUGE, LOUISIANA, AREA

Well No.	K'* $CaCO_3$ 10^{-10}	ΔK** $CaCO_3$	K'* $CaMg(CO_3)_2$ 10^{-20}	ΔK** $CaMg(CO_3)_2$	$\log[K^+]/[H^+]$	$\log[H_4SiO_4]$
			"1500-ft Sand Aquifer"			
EB-782A	9.23	- 0.81	24.00	- 0.98	3.16	- 3.29
WBR-100A	0.43	- 0.99	0.04	- 0.99	3.00	- 3.26
EB-803A	5.10	- 0.89	20.00	- 0.99	3.04	- 3.35
EB-771	1.04	- 0.97	0.00	- 1.00	2.98	- 3.36
EB-792A	0.53	- 0.98	0.24	- 0.99	2.98	- 3.36
EB-777	4.96	- 0.90	40.80	- 0.97	3.58	- 3.23
EB-780B	7.82	- 0.84	19.21	- 0.99	2.51	- 3.41
EB-157	0.00	- 1.00	0.00	- 1.00	4.04	- 3.41
EB-510	1.94	- 0.96	4.73	- 0.99	3.52	- 3.22
EB-807A	0.47	- 0.99	0.00	- 1.00	2.45	- 3.28
			"1700-ft Sand Aquifer"			
EB-68	4.58	- 0.90	13.11	- 0.99	4.32	- 3.30
WBR-4	0.30	- 0.99	0.16	- 0.99	3.25	- 3.36
			"2000-ft Sand Aquifer"			
EB-803B	3.10	- 0.93	5.45	- 0.99	2.74	- 3.33
WBR-100B	1.27	- 0.97	0.12	- 0.99	2.97	- 3.33
WBR-106	1.93	- 0.96	0.22	- 0.99	3.17	- 3.32
EB-778	4.68	- 0.90	2.74	- 0.99	3.43	- 3.36
EB-792B	1.25	- 0.97	1.75	- 0.99	3.17	- 3.45
EB-367	3.75	- 0.92	1.79	- 0.99	2.85	- 3.39
WBR-32	0.74	- 0.98	0.11	- 0.99	2.47	- 3.39
EB-754	2.88	- 0.94	2.27	- 0.99	2.88	- 3.43
EB-774	1.28	- 0.97	0.00	- 1.00	2.65	- 3.43

TABLE B-2

SOLUBILITY VALUES IN THE GROUND WATER OF THE BATON ROUGE, LOUISIANA, AREA

Well No.	K'* $CaCO_3$ 10^{-10}	ΔK** $CaCO_3$	K'* $CaMg(CO_3)_2$ 10^{-20}	ΔK** $CaMg(CO_3)_2$	$\log[K^+]/[H^+]$	$\log[H_4SiO_4]$
EB-781	30.04	- 0.39	66.88	- 0.96	3.39	- 3.43
EB-770	2.48	- 0.95	0.00	- 1.00	3.04	- 3.47
EB-444	0.95	- 0.98	0.45	- 0.99	3.17	- 3.39
EB-817	4.34	- 0.91	3.91	- 0.99	3.35	- 3.50
EB-456	23.94	- 0.52	145.55	- 0.92	4.70	- 3.41
EB-384	16.56	- 0.66	12.18	- 0.99	4.14	- 3.36
EB-804A	0.00	- 1.00	0.00	- 1.00	2.64	- 3.39
EB-807B	2.25	- 0.95	0.00	- 1.00	2.77	- 3.45
EB-783A	7.90	- 0.84	27.02	- 0.98	3.67	- 3.36
			"2400-ft Sand Aquifer"			
EB-468	36.51	- 0.26	1582.10	- 0.20	4.19	- 3.41
EB-352	18.23	- 0.63	137.59	- 0.93	4.79	- 3.43
EB-551	12.49	- 0.75	87.25	- 0.95	3.69	- 3.39
EB-794	3.69	- 0.92	0.00	- 1.00	3.25	- 3.43
EB-806B	22.67	- 0.54	509.80	- 0.99	3.22	- 3.32
EB-783B	41.84	- 0.16	0.00	- 1.00	3.78	- 3.50
EB-804B	5.44	- 0.89	2.14	- 0.99	2.64	- 3.41
EB-718	3.05	- 0.93	3.42	- 0.99	2.95	- 3.43
EB-568	1.00	- 0.98	0.20	- 0.99	2.57	- 3.43
EB-294	4.60	- 0.90	17.86	- 0.99	3.89	- 3.50
EB-572	61.04	+ 0.22	0.00	- 1.00	4.12	- 3.38

TABLE B-2

SOLUBILITY VALUES IN THE GROUND WATER OF THE BATON ROUGE, LOUISIANA, AREA

Well No.	K'* $CaCO_3$ 10^{-10}	ΔK** $CaCO_3$	K'* $CaMg(CO_3)_2$ 10^{-20}	ΔK** $CaMg(CO_3)_2$	$\log[K^+]/[H^+]$	$\log[H_4SiO_4]$
			"2800-ft Sand Aquifer"			
EB-798	15.56	- 0.68	109.42	- 0.94	3.72	- 3.47
EB-578B	29.60	- 0.40	221.65	- 0.88	4.20	- 3.43
EB-378	24.76	- 0.50	171.37	- 0.91	3.82	- 3.33
EB-517	18.40	- 0.63	164.83	- 0.91	3.87	- 3.38
EB-534	10.35	- 0.79	29.60	- 0.98	3.46	- 3.36

APPENDIX C

CALCULATION OF ΔK

Conversion of the Analytical Chemical Data for use in Equilibrium Studies

Individual chemical analyses of the ground water were converted from parts per million to molality, by the formula:

$$\text{molality} = \frac{\text{parts per million}}{\text{formula weight}} \times 10^{-3} \quad \text{(i)}$$

$$= \frac{\text{equivalent per million}}{\text{valence of the ion}} \times 10^{-3} \quad \text{(ii)}$$

Later molality was used to calculate the ionic strength (I) of the solutions by the relationship:

$$I = \tfrac{1}{2}\sum m_i z_i^2 \quad \text{(iii)}$$

where m_i is molality of i ion and z_i is charge on the i ion. The activity coefficient γ may be determined for the individual ions by using the Debye-Huckel equation:

$$-\log \gamma_i = \frac{A z_i^2 \sqrt{I}}{1 + a_i^{\circ} B\sqrt{I}} \quad \text{(iv)}$$

where A and B are temperature dependent constants of the solvent, z_i is the charge on the ion, a_i° is the effective diameter of the ion and I is the ionic strength. The constants for use in the above equation are compiled in Garrels and Christ (1965). The

activity or effective concentration of the ion in solution may be obtained by multiplying molality by the activity coefficient:

$$\alpha_i = m_i \ \gamma_i \qquad \text{(v)}$$

where α is activity of the ion. The calculated activities of the major chemical constituents of the ground water samples in the Baton Rouge area are listed in Appendix B, Table B-1

Chemical Composition of Ground Water As A Function of Solubility of Aquifer Minerals

The dissolved-ion activity product K_{IAP} of the commonly occurring carbonate minerals such as calcite and dolomite, which presumably may have dissolved to produce the present chemical character in the ground water, may be calculated from the appropriate chemical reaction, in the case of calcite in equilibrium with its dissociation products:

$$CaCO_3 = Ca^{2+} + CO_3^{2-}$$

The equilibrium constant for such a reaction would be (Garrels and Christ, 1965):

$$K_{calcite} = \frac{[Ca^{+2}]\ [CO_3^{-2}]}{[CaCO_3]} = 10^{-8.3} \qquad \text{(vi)}$$

Since the activity of pure or nearly pure $CaCO_3$ at 25° at 1 atm. pressure may be assigned unity, equation (vi) can also be written as:

$$K_{calcite} = [Ca^{+2}]\ [CO_3^{-2}] \qquad \text{(vii)}$$

The activity of the carbonate ion can be calculated from the pH and measured bicarbonate values by:

$$K_{HCO_3^-} = \frac{[H^+][CO_3^{2-}]}{[HCO_3^-]} = 10^{-10.3} \quad \text{(viii)}$$

Similarly, K_{IAP} for dolomite may also be calculated as follows from the equation for the dissolution of dolomite:

$$CaMg\ (CO_3)_2 = Ca^{2+} + Mg^{2+} + 2CO_3^{2-} \quad \text{(ix)}$$

where the equilibrium constant for the above reaction may be represented by:

$$K_{dolomite} = \frac{[Ca^{2+}]\ [Mg^{2+}][CO_3^{2-}]}{[CaMg(CO_3)_2]} = 10^{-17.0} \quad \text{(x)}$$

There is a wide range of speculation in the K_{sp} value of dolomite at low temperature (25°C), which ranges between $10^{-16.7}$ (Hsu, 1963) and $10^{-19.3}$ (Garrels et al., 1960). A value of $10^{-17.0}$ may be taken as close to many equilibrium values derived for dolomite. This variability has given rise to much discussion (Back et al., 1966; Carpetner and Miller, 1969).

Calculated values of K_{IAP} for dolomite and calcite are listed in Appendix B, Table B-2.

Solubility studies of gypsum were not made because gypsum was not found during the mineralogical studies and the SO_4 content in the ground water was very low. Similar calculation can also be

made for other minerals. Any water saturated or oversaturated with pure $CaCO_3$ is even more so for aragonite or high Mg calcite since these are both more soluble than low Mg calcite (Chave, et al. 1962).

Comparison of Natural Conditions with Equilibrium Condition

The K_{IAP} values of ground water were compared with previously established K_{sp} values. To estimate the departure from the equilibrium condition, the following relation has been utilized:

$$\Delta K = \frac{K_{IAP} - K_m}{K_m} \qquad \text{(xi)}$$

where K_{IAP} and K_m represent constants obtained by the method discussed above,

$$\Delta K = \frac{K_{IAP}}{K_m} - 1 \qquad \text{(xii)}$$

ΔK for calcite and dolomite have been calculated for individual ground water samples and are listed in Table B-2. A positive ΔK value indicates the relative magnitude of saturation, while a negative ΔK value is indicative of undersaturation, whereas a zero ΔK value suggests equilibrium. Positive ΔK values may indicate the capability of ground water to precipitate, while negative ones indicate its capability of dissolution.

VITA

Rashid Ali Khan was born on July 1, 1942, in Gorakhpur in the province of Uttar Pradesh, India. He completed his primary education in various schools in India and obtained his high school certificate in 1957. He was graduated from Aligarh Muslim University in India with a B.Sc. degree in 1963 and M.Sc. degree from the same university in 1965. He was awarded the University Medal for obtaining first position in the M.S. examination in 1965. He was working as Lecturer in the Department of Geology, Aligarh Muslim University, when he was awarded a United States Travel Grant and a Research Assistantship in the Department of Geology, Louisiana State University in Baton Rouge, to pursue studies in the fields of geochemistry and hydrogeology. He is a member of the Geological Society of America.

EXAMINATION AND THESIS REPORT

Candidate: Rashid Ali Khan

Major Field: Geochemistry

Title of Thesis: Geochemical Hydrology of Ground Water in Baton Rouge, Louisiana

Approved:

Ray E. Ferrell Jr.
Major Professor and Chairman

Max Goodrich
Dean of the Graduate School

EXAMINING COMMITTEE:

C V Durham

Clyde D. Moore Jr.

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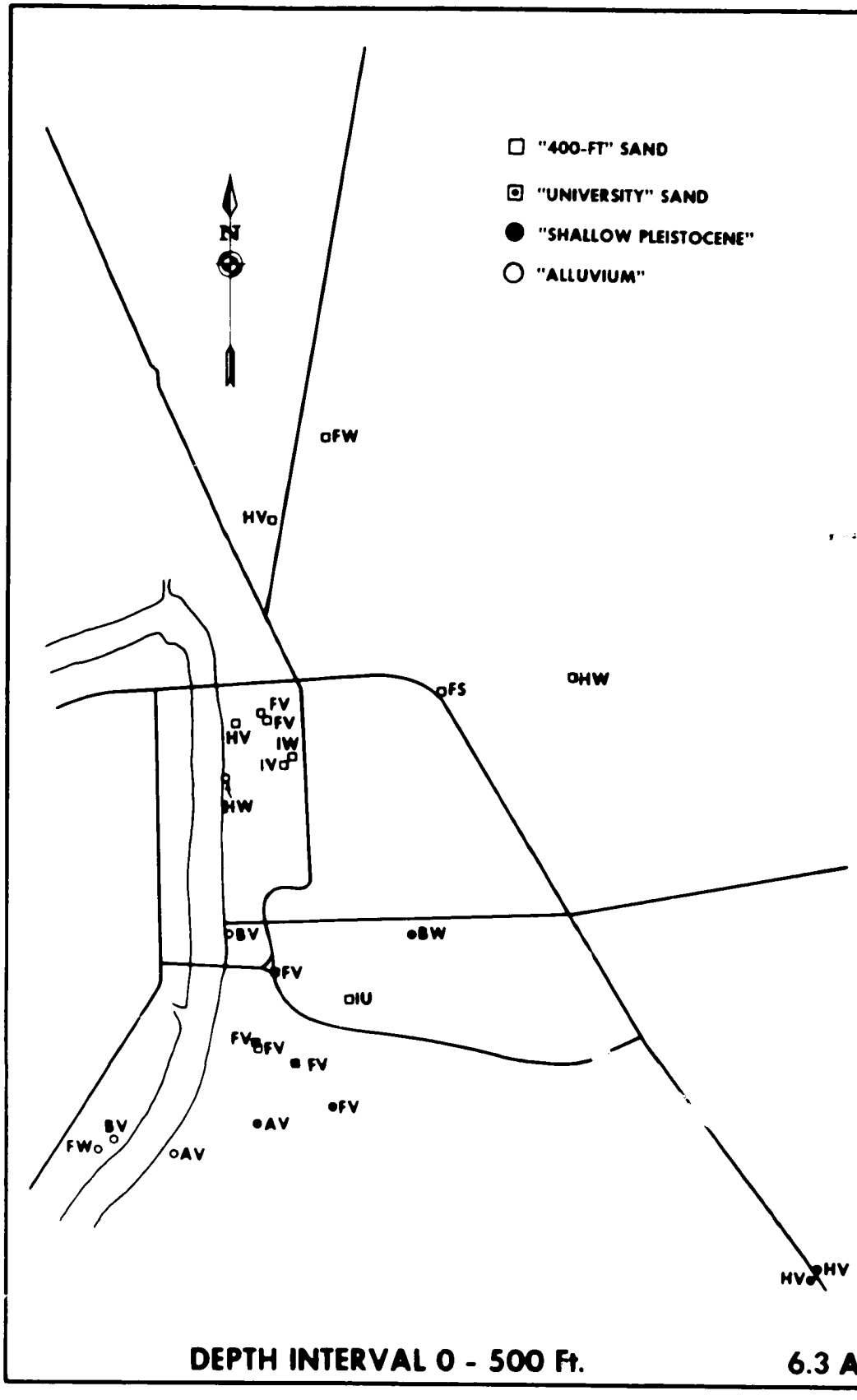
Dale K. Billings

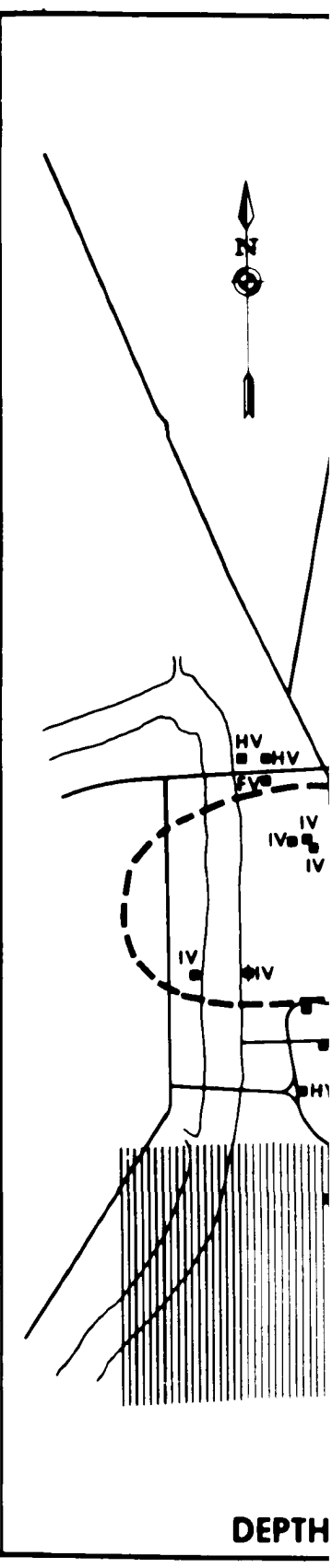
Date of Examination:

August 6, 1970



DEPTH INTERVAL 0 - 500 Ft.

6.3 A



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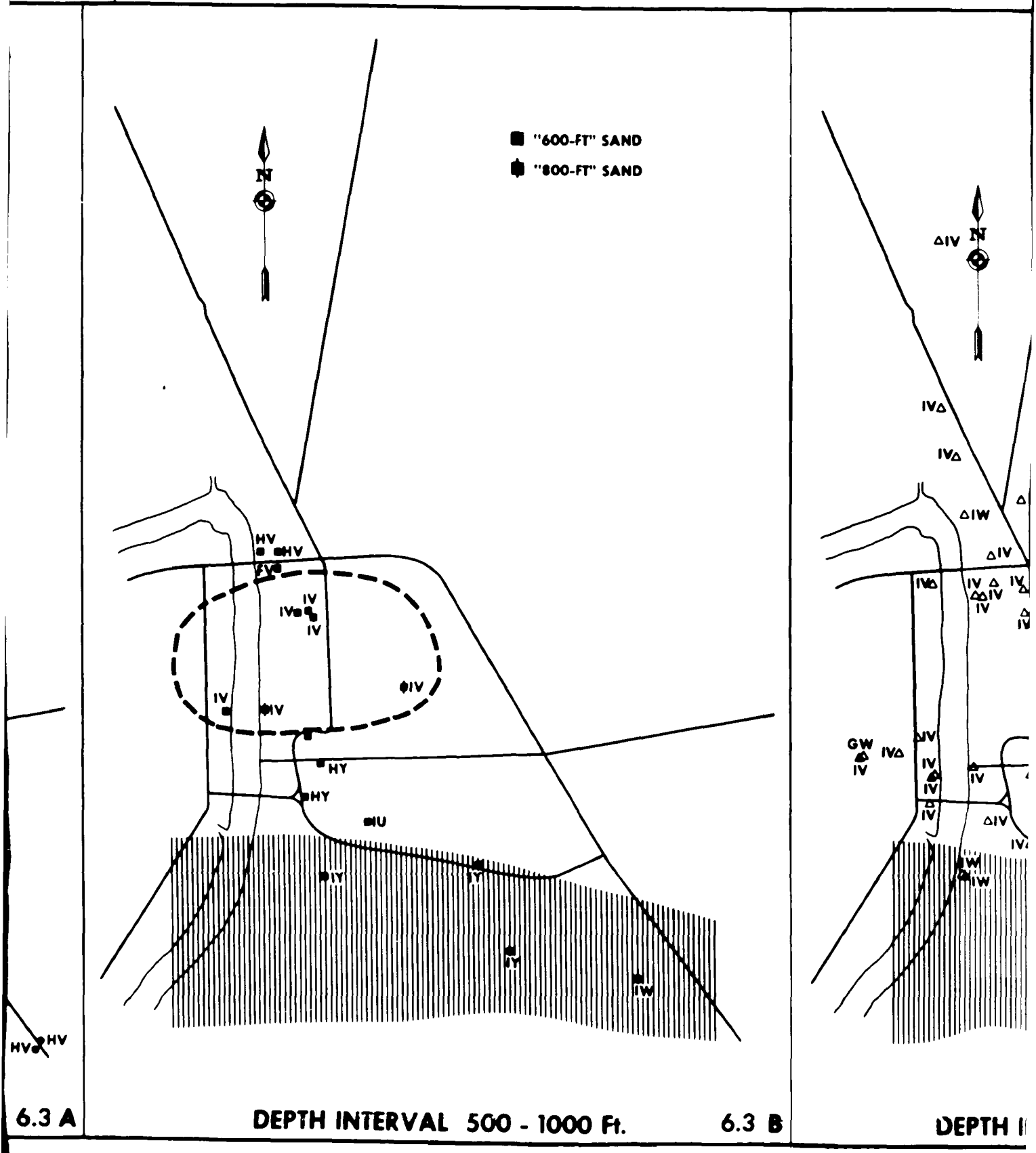
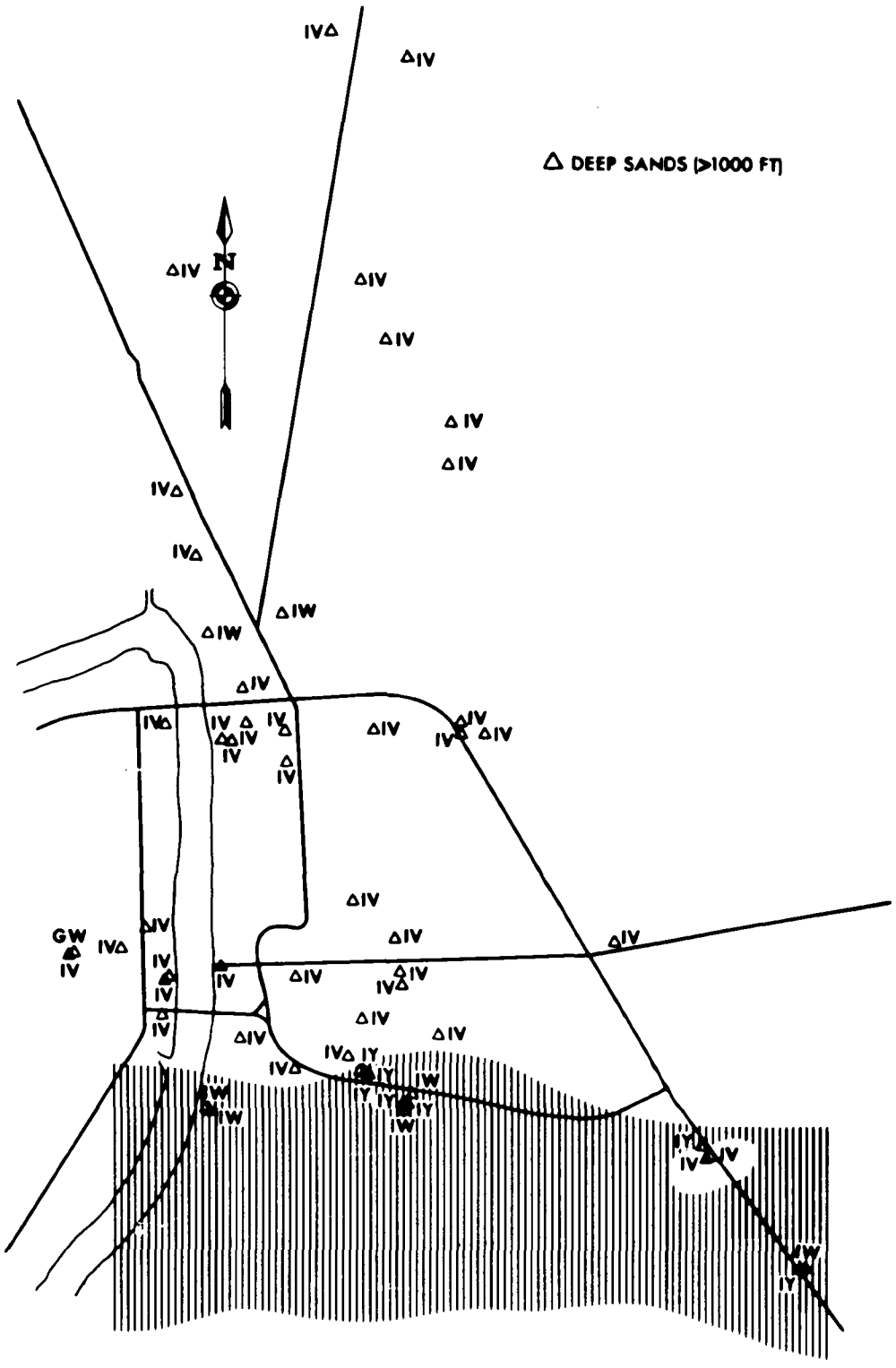




DEPTH INTERVAL 1000 - 2800 Ft.

6.3 C

DISTRIB

ABBRE

Cation Fac

Ca > Mg

Ca > Mg > Na

Ca > Na > Mg

Mg > Na

Ca > Na

Na > Ca > Mg

Na > Mg

Na > Ca

Na

DISTRIBUTION OF HYDROCHEMICAL FACIES

LEGEND

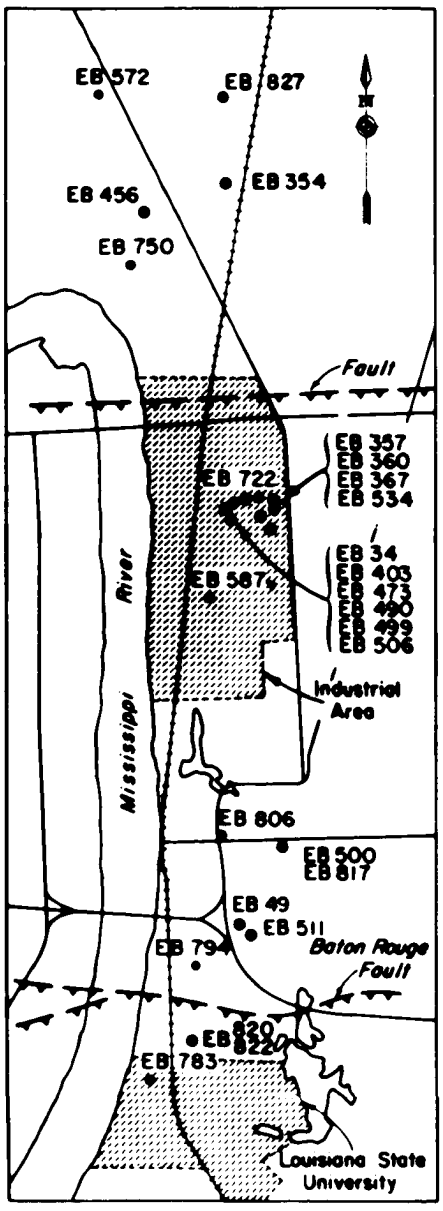
ABBREVIATIONS FOR HYDROCHEMICAL FACIES

Cation Facies		Anion Facies	
Ca > Mg	A	$HCO_3 > SO_4 > Cl$	S
Ca > Mg > Na	B	$HCO_3 > Cl > SO_4$	T
Ca > Na > Mg	C	$HCO_3 > SO_4$	U
Mg > Na	D	HCO_3	V
Ca > Na	E	$HCO_3 > Cl$	W
Na > Ca > Mg	F	$Cl > HCO_3 > SO_4$	X
Na > Mg	G	$Cl > HCO_3$	Y
Na > Ca	H	Cl	Z
Na	I		

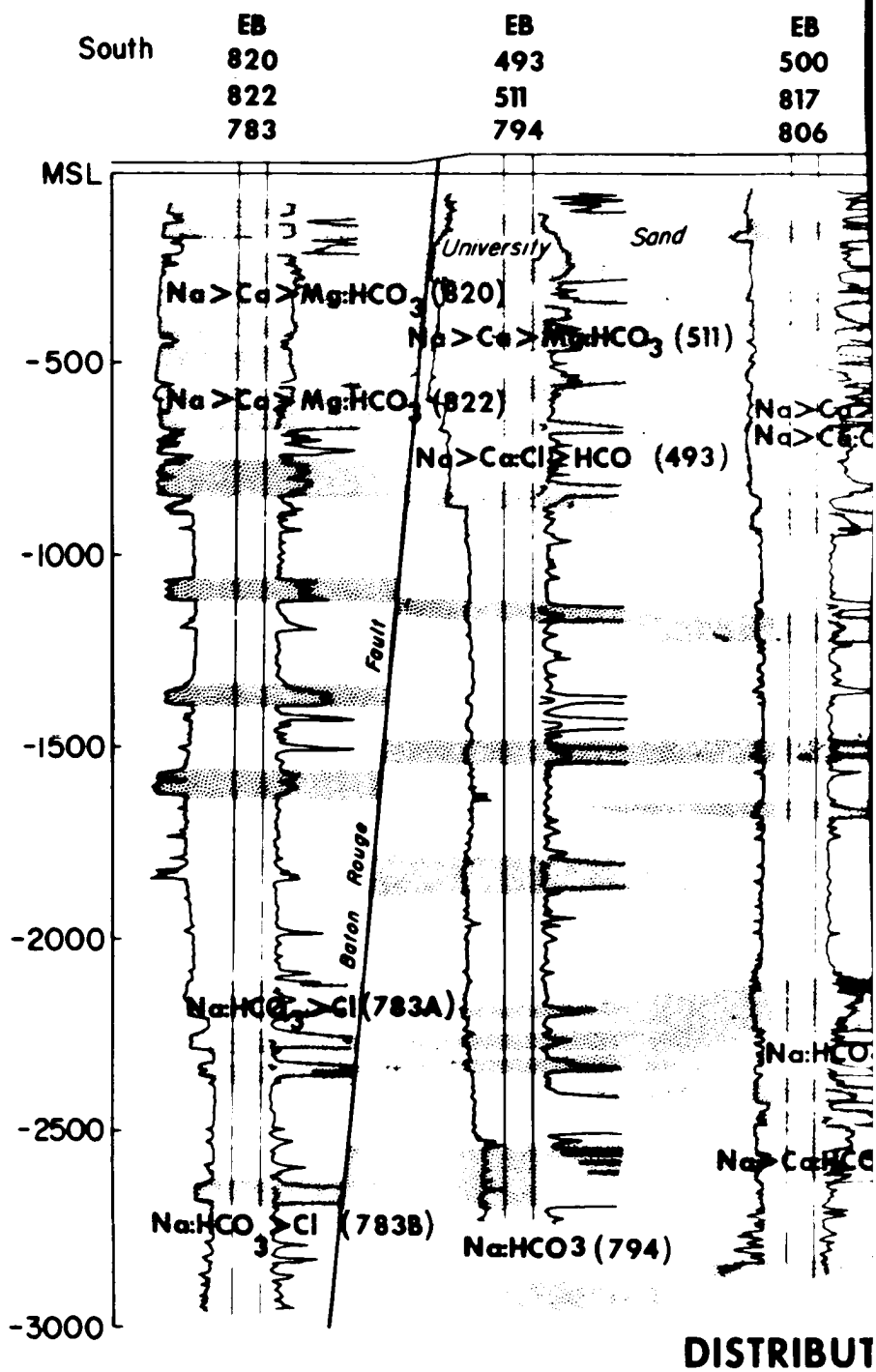
0 1 2 3 4 5 MILES

6.3 C

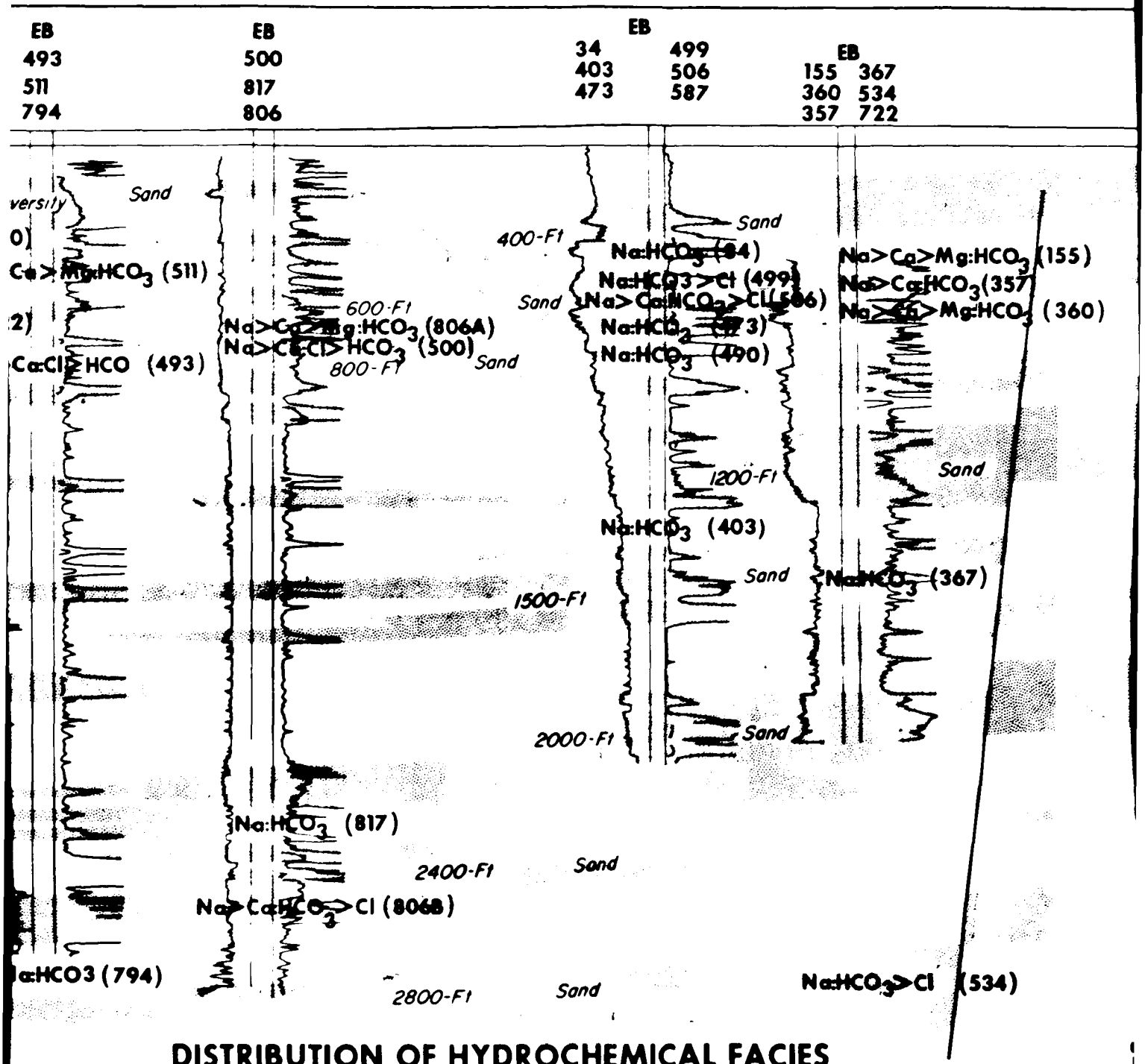
FIG. 6.3



LOCATION MAP



GEOLOGICAL SECTION KAZMANN (1970)



DISTRIBUTION OF HYDROCHEMICAL FACIES

(NORTH-SOUTH CROSS SECTION)

BATON ROUGE AREA

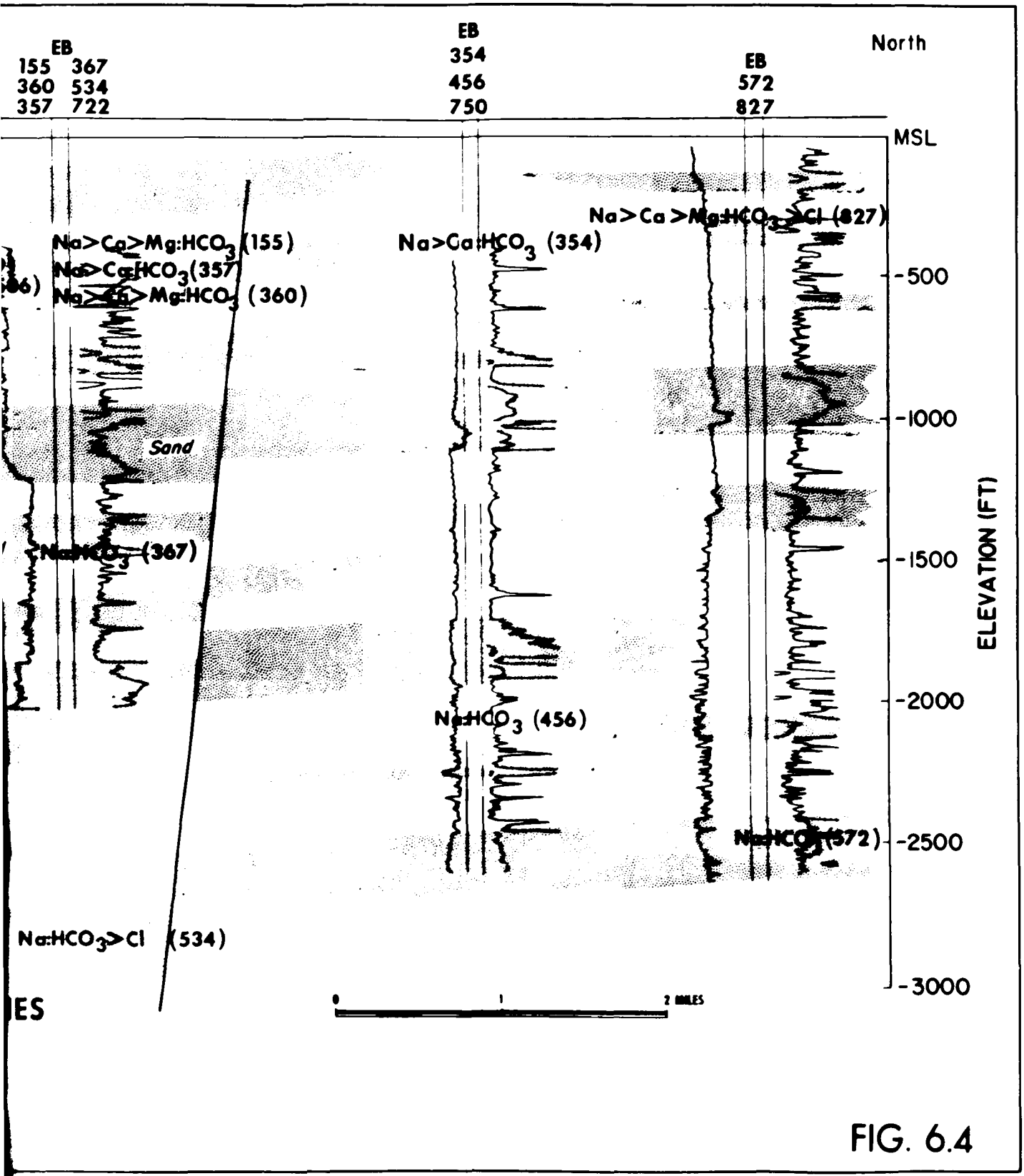
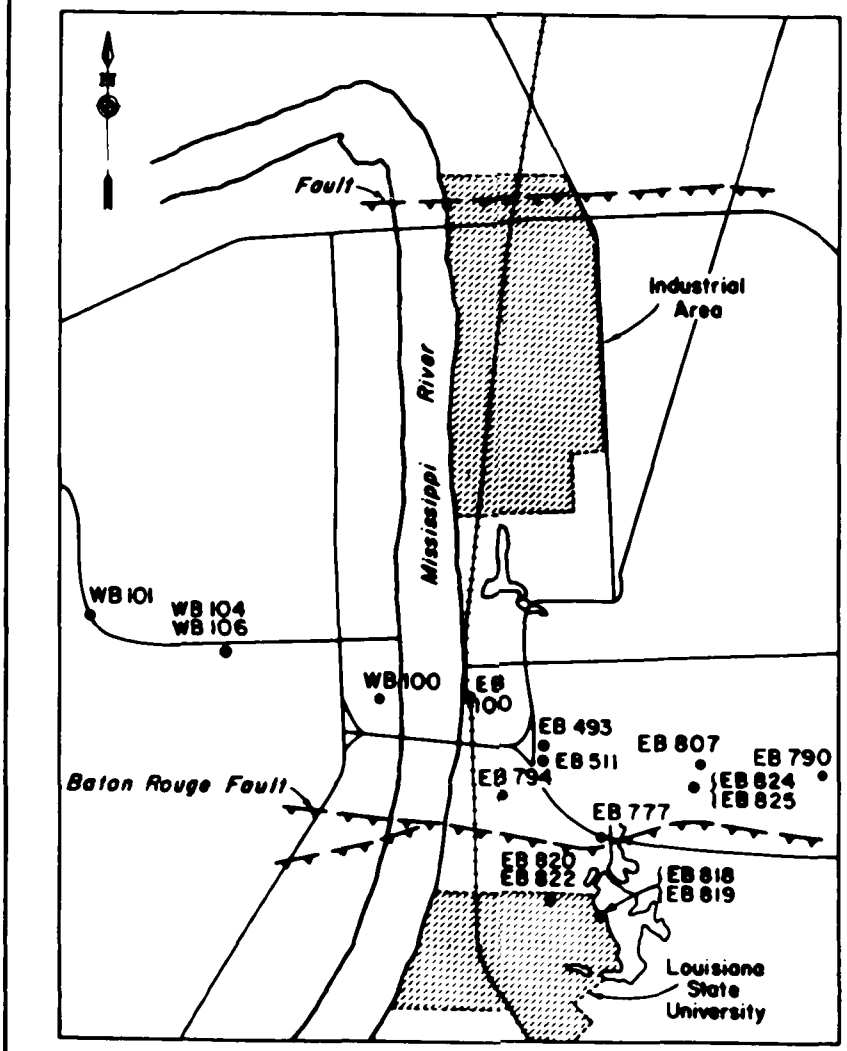
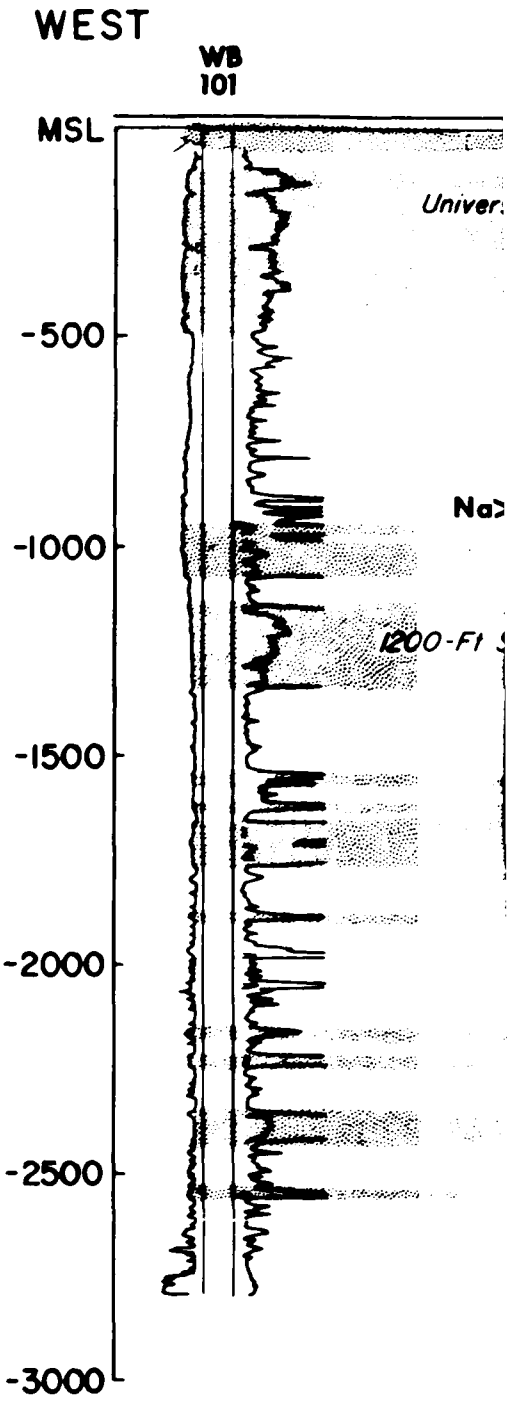


FIG. 6.4



LOCATION MAP



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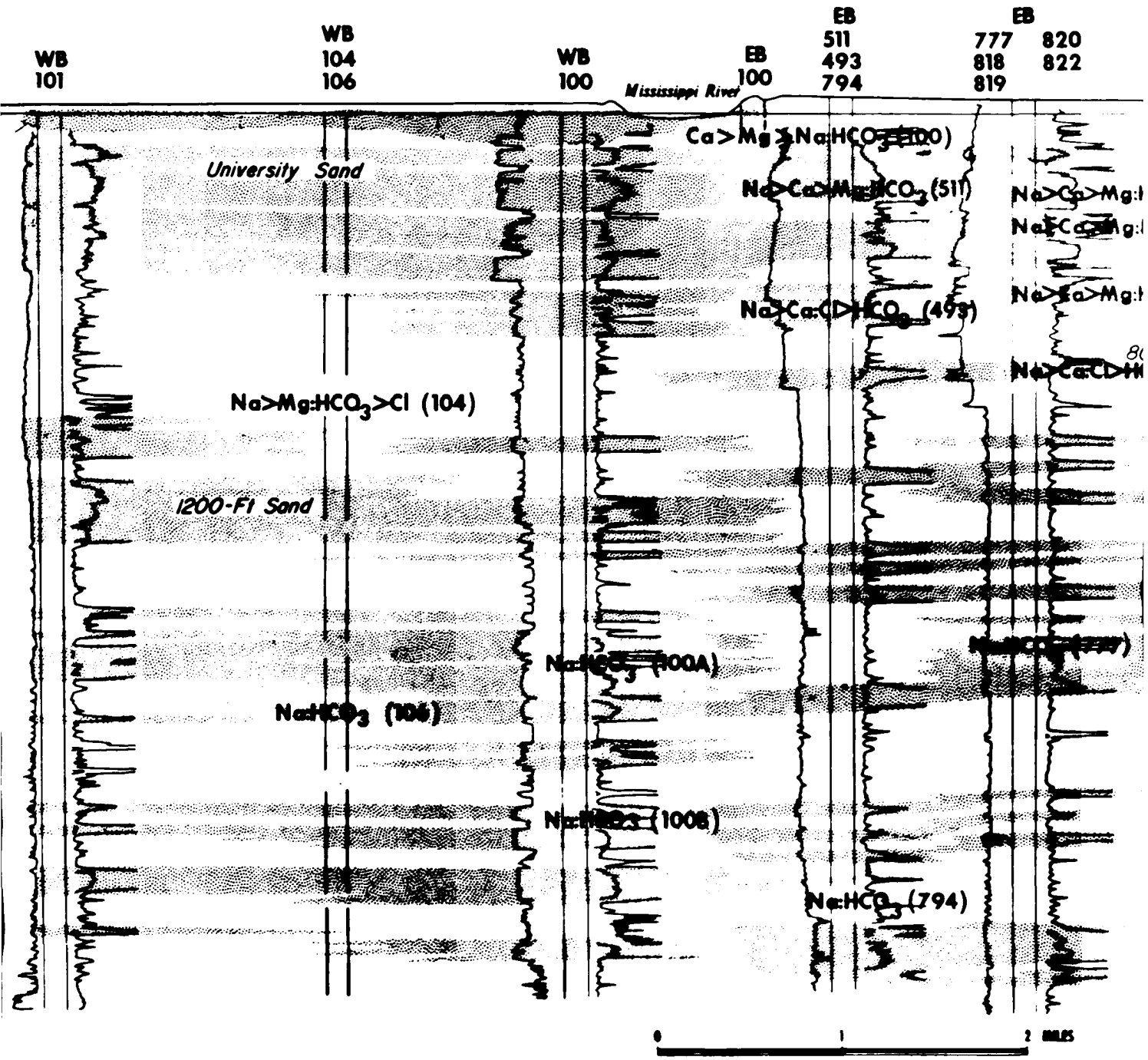
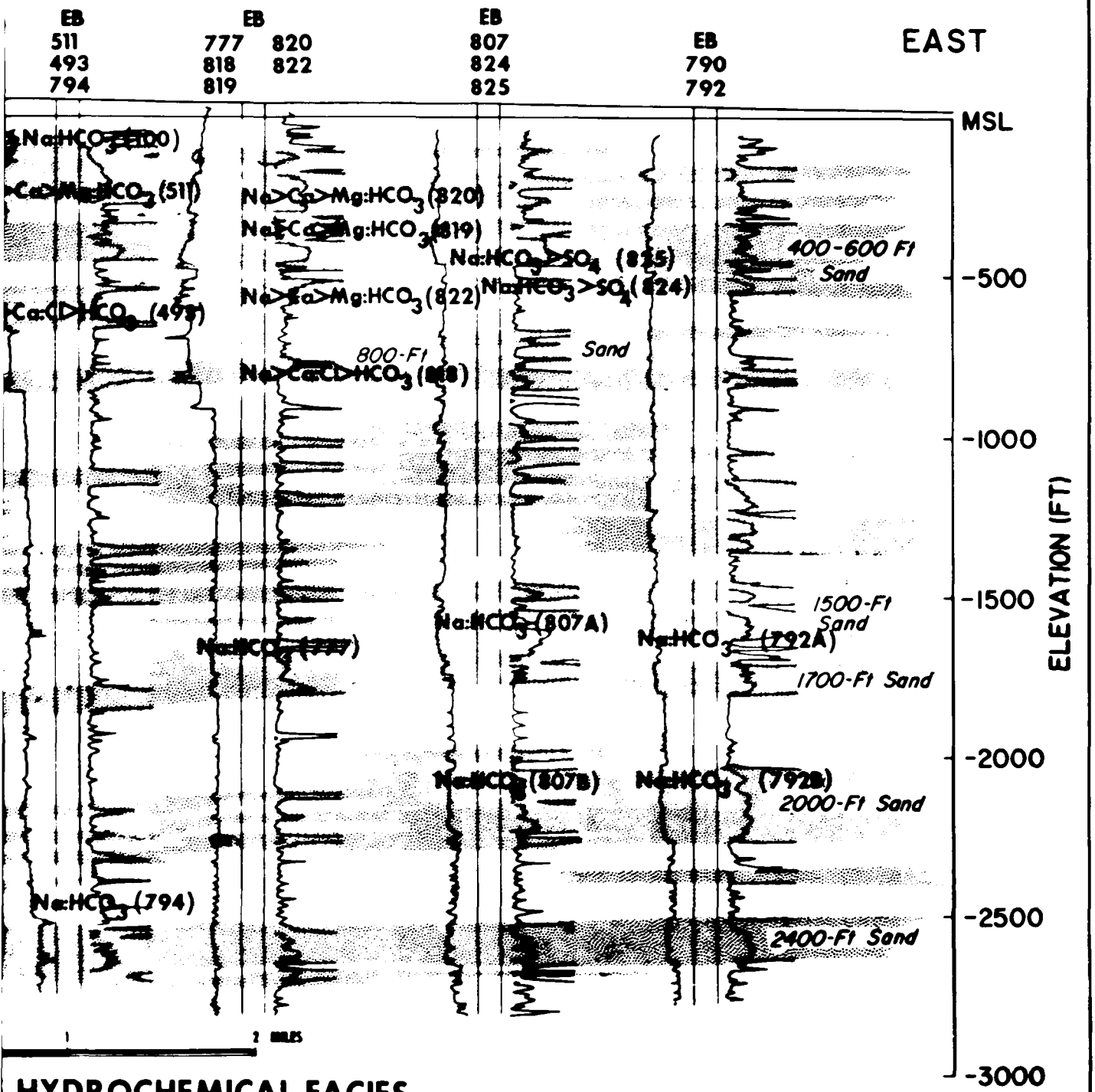


DISTRIBUTION OF HYDROCHEMICAL FACI

(EAST-WEST CROSS SECTION)

BATON ROUGE AREA



HYDROCHEMICAL FACIES

ST CROSS SECTION)

N ROUGE AREA

FIG. 6.5